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THE GROWTH OF ELECTRIC LIGHTING IN LONDON.

THE subject of the growth of electric lighting in London presents, perhaps, the most interesting chapter in the history of electric lighting. It is a chapter, one of the most remarkable, and without parallel, in any industry which has sprung up within recent times. Unhappily, the history is not an unblemished record, for in the early days some of the shadiest transactions that were ever carried out in the City of London were perpetrated. Ruin and disaster resulted to many families, the hard-earned savings of thousands of men and women were placed irretrievably beyond recovery, and the feverish hopes of reckless speculators were raised beyond all reasonable expectations. In fact, the name of electric lighting was an *open sesame* to the pockets of the most prudent, and people were as eager to cast their wealth at the feet of the goddess Electra as the temporary directors of the said goddess were to manipulate it. But the sword of Damocles was suspended, and ruin soon overtook those who had embarked in the treacherous undertakings.

Thus it comes to pass that the electric light enterprises of 1882 will go down the pages of history in company with such gigantic ill-conceived schemes as the South Sea Bubble. It is not surprising, therefore, that when a correspondent of the *Times* the other day treated upon the subject of the growth of electric lighting in London that his particular opinions should not pass unchallenged. The article has evoked letters from Mr. Crompton, Mr. Massey, Prof. Kennedy, and others, in addition to which Mr. Massey has been interviewed at considerable length by the *Oracle* upon the subject.

Now that the matter may be considered to have passed beyond the controversial stage, it may be interesting to examine the views put forward on this important subject. That Mr. Crompton in his reply made out a good case against the writer in the *Times* no one can gainsay; but at the same time the conclusion forces itself upon one that it resembled more the speech of an advocate pleading eloquently for a given cause than the calm, unimpassioned words of an unbiassed spectator.

In saying this we are not detracting in the least degree from the sincerity of Mr. Crompton's views, for had there been in 1882 men possessing Mr. Crompton's energy, and imbued with the same desire for honest work, electric lighting would have occupied a more honourable position than it then attained. To Mr. Massey is due the credit of saying, perhaps, the most outspoken things concerning electric lighting that ever fell from the lips of an electrician. It would be idle to say that he does not occasionally fall into error, but in the interview which we have mentioned, we see nothing but a genuine attempt to clear away many of the misconceptions and fallacies too often perpetuated by scientific men; and although Mr. Crompton twits Mr. Massey with being a pessimist, and one whose experience lies in directions other than electric lighting, he is perhaps, for that very reason, better able to give an unbiassed and candid opinion. Certainly, the tendency hitherto has been to give a too roseate hue to things electrical, and it would be an advantage if we were to climb down a little, and not claim too much. If that were the case, it would result in nothing but gain for electricity all round. Exaggeration never served any useful purpose yet, and if electricians, managers of electric light companies, and others, were to bear that fact well in mind, it would help to prevent the dissemination of erroneous opinions.

The *Times* correspondent distinctly emphasised the fact that it was not the Chamberlain Act of 1882 which hindered the progress of electric lighting. With this conclusion we have always agreed, for, as Mr. Massey says, it did more good than harm. It certainly checked the wild rush of speculators who were bent upon acquiring fabulous sums without an equivalent return. We can quite see that if the Chamberlain Act had not been passed, things—bad as they were—would have reached such a pass that electrical enterprise would not have recovered for at least twenty years. Mr. Crompton, however, in his letter to the *Times*, thinks fit to deny this statement, and affirms that it was the Chamberlain Act alone which hampered electric light. He does not

attempt to prove his case, but dwells upon the fact that the knowledge and machinery were as good then as they are now. Granting that this was the case, which we do not altogether admit, we fail to see how it affects the matter at issue. It was not so much the question of science as the question of obtaining financiers with legitimate commercial objects. If capitalists as genuine as Mr. Crompton and his dynamos had taken up the subject in a proper spirit of trading, electricity might have occupied a respectable position long ago. The Chamberlain Act at any rate did not prevent Sir Coutts Lindsay, Lord Crawford and others from carrying on operations at the Grosvenor Gallery; in short, progress which was real and lasting was not hindered in the least degree. As to Mr. Crompton's contention that appliances were very little inferior then to those now manufactured, we would point out that all the machines then in existence were not made by Crompton, nor would it have been possible, supposing that supply companies had been formed, for engineers to have been found with all the resources and experience of Mr. Crompton, and the result would have been that incompetent men would have undertaken the lighting of towns with most disastrous consequences. The fact remains incontrovertible that there was no real desire on the part of electrical promotors of 1882 to undertake sound work. The sole objects were the securing of patents, the striving to sell at the highest possible price, and the flotation of subsidiary companies. It was no part of the adopted scheme to enquire into the real value of an electrical appliance, it was sufficient that it was electrical for it to command the most fabulous sum. We may with advantage at this point quote an incident mentioned by the *Times* correspondent, which shows the utter folly and wretched management of a great concern. There was formed in 1883, after the passing of the Act, the Metropolitan (Brush) Electric Light and Power Company, Limited, with a capital of £1,000,000; of the whole capital subscribed, a quarter of a million was paid for the right to use in the metropolis Brush dynamos and lamps, and Lane-Fox incandescent lamps. Although the company was debarred from using any other apparatus, it could not at that moment run a single dynamo capable of supplying current to glow lamps; their machinery was, in fact, intended only for arc lamps. In a case such as this it would be manifestly unfair to blame the Chamberlain Act for the incompetence of a board of directors, an incompetence which was admitted on all hands.

Coming down to the present day, one sees a real activity now prevailing; unlike the activity of 1882, it is now in the right direction. In spite of this forward movement, however, one is apt to make too much of the capabilities and prospects of electric lighting. Since the amended Act was passed a good many electric light companies have been formed, and, apparently, it is thought that it is only necessary to fix the machinery and to start lighting, for the company to begin paying dividends. If such is the case, the result may be disappointing. Mr. Crompton points out that, in order to make electric light companies a financial success, it is necessary to obtain the confidence of the public. This is a self-evident assertion, and in this respect electric light companies do not differ from any other caterers to the wants of the public. But it must be remembered that this confidence will not be easily obtained, and although people possessing valuable paintings and books and costly decorations recognise at once the superiority of electricity over any other illuminant, it must be borne in mind that it is only a small minority which owns high-class pictures, and that with the great majority the question will chiefly present itself in the initial cost of the light. People in general are not over fond of placing abstract advantages to the credit side of the account; they judge more from the actual effect on the pocket. It is idle, therefore, to point to instances like the St. James's Company, which admittedly has obtained the "cream" of electric lighting, as a dividend-paying concern.

As Mr. Massey rightly observes, it must not be expected that electric lighting in residential districts will pay at present prices; and, as properly argued by him, the tendency to use electricity extravagantly in the first quarter will be eradicated by the time the second account is presented. As the majority of electric light companies are, or will be situated in residential districts, it is only reasonable to suppose that great alterations must be effected before the light may be fairly considered to have passed the threshhold of the middle-class dwelling. There is no denying the fact that as an illuminant electricity is far away the best, and all things considered it may be worth three or four times the price of gas. It is, however, only the heads of public offices, institutions and printing offices, who recognise the improved hygienic conditions under which employés labour when electricity is used, and in these cases the private installation is mostly used. It therefore remains that until the price of electricity is nearly equivalent to that of gas, a large body of the community will steadily refuse to adopt it. Of course, if the public can be educated up to the standard of seeing that electricity is necessary for a proper state of being all well and good, but we have not much faith in convincing the public by these measures.

Mr. Massey gives prominence to a detail which is often lost sight of in lighting one's house with plant on the premises, and that is the attention necessary to ensure the proper working of the generating plant. Previously the gas necessary to light Mr. Massey's house cost him £17, using electricity the cost was £10, but this might be made the basis of a most misleading calculation, for the attention which was necessary was reckoned by Mr. Massey at £100, a fact which makes all the difference in the world. Of course, this would not be the actual figure in an ordinary house, where a boy was employed to look after the dynamo; but the salary of the boy, however small, would alone make considerable difference in the cost.

As to the question whether electric light companies will pay in London, it is a matter which only the future can decide. As we have pointed out, there will be little difficulty in companies such as the St. James's Company, earning a fair dividend; but for others in poorer districts we are afraid a dreary period is before them. This may be shorter than we anticipate. We trust it may, for there is no doubt whatever that electric light companies will, one day, take up their proper position in the commercial world.

We have often stated in the columns of the REVIEW that the accounts of electric light companies do not show the actual state of things. As pointed out in the *Oracle*, there is the temptation in all new enterprises to place to capital account expenditure which ought really to come

under the head of current receipts. This is neither wise nor necessary, for accounts lose nothing by their clearness. In cases where electric lighting is taken up by municipalities, as is pointed out, the coal differences ought to be well understood. At Cardiff, for instance, where gas coal is scarce, steam coal is in abundance, so that electricity in this case might fairly compete with gas; but at other places gas coal is cheap, with the result that electricity may not succeed in supplanting gas.

Mr. Massey remarked, in the course of his interview, that the electric light industry in America was a long way behind England. We presume that Mr. Massey refers only to domestic lighting, for we might mention that the arc lighting industry, as given by statistics, has reached enormous proportions. The *Times* correspondent, in replying to his critics, dwells upon the fact that large steam engines are much more economical than small ones, and asks how Mr. Bailey, of the Metropolitan Electric Supply Company, would like to break up his system into 150 or 200 units? We would point out that Mr. Bailey has always advocated and used reasonably small units. As to the real economy of the large engine, we quite agree with Prof. Kennedy; that it is a most common error. As he says: "There is no evidence whatever that an engine and dynamo of 2,000 horse-power is in the least more economical than one of 200 horse-power." Probably no one has had greater experience of steam plant than Prof. Kennedy, and practical electrical men will recognise the truth of his remarks. As to a dynamo running economically at full load, we fail to see how the best economy is to be obtained unless small units are employed. In the words of Prof. Kennedy, "the difference in efficiency between a large and a small unit fully loaded is nothing, but every lamp lit by a current from a large machine, working at quarter load, requires literally about double as much coal and power than if it were lit by a smaller machine fully loaded." Discussion on the relative merits of different systems are perhaps scarcely within the range of this article, but at any rate we may venture to prophecy that five years will see the survival of the fittest. As to the correspondence which has taken place in the *Times*, we must congratulate all concerned upon the fair and decorous spirit which has characterised the utterances, and we regret that we are unable to publish the letters in full.

Dr. Lodge's National Laboratory Proposal.

THE proposal of Dr. Lodge to form a national laboratory for the purposes of research in physics has found a ready support in the columns of our contemporary, *Industries*. In urging the necessity for such an institution the writer cuts rather scathingly at the present conditions under which research work is carried on in existing technical schools and colleges. "It would not be difficult," he says, "to find professorial chairs occupied, not by teachers, but by inventors and discoverers." This discovery, we think, is a piece of pure invention on the part of the writer; the experience of the world from all time having shown that, in the domain of science at least, those are the successful teachers whose work of invention and discovery goes hand in hand with their teaching. That there are science teachers who are neither inventors nor discoverers it is scarcely necessary to deny; but all the highest educational work is, and has ever been, entrusted to men of originality of thought and research in this department. The first are historians merely; the second are historians and makers of history. The one may be as "sorely tempted" to waste the time of his students by text-book fables, and romances from old sources, as the other by too great a tendency to research. "From an educational point of view" we must not overlook the fact that practical laboratory work is not to be regarded as *acquisitive* only. There is a *creative* element about it which must not be passed over; and no better field for the development of the creative faculties can be found than the research department of a well organised physical laboratory. For "highly specialised research work" it is natural that the professor should nominate those students only who are sufficiently advanced in acquisitive knowledge and manipulative skill for his purpose. The compensation for "time and money expended by the student in the brief and valuable years of his college course" is not merely "the luxury of obtaining a trifling and almost momentary attention on rare occasions from a man of European reputation;" this is insignificant compared with the expanding of the faculties brought about by the important change in the order of work.

Copper Tubes.

RUSSIANS knew how to make copper tubes by electrolysis before English companies had been started to do the same thing. At the Universal Paris Exhibition of 1867, in Class 40, No. 518, Fedor Gabrilovitch Fedoronsky, inspector of the electroplating works of the Naval Department at Cronstadt, exhibited some iron pipes galvanically coated with copper, and also some copper tubes made by electrolysis. We find in the Jury's Report, Group VI., Tome 8, p. 135, the following particulars on the copper tubes made by Fedoronsky's electrolytic process:—"Some of his seamless tubes were straight, some were elbowed, or had a double bend; there were also some three-branch pipes. The thickness of the pipes varied between 0·75 mm. and 0·915 mm., and the diameter was from 3 to 240 mm.

Underground Railways and Electricity.

SEEING that the electric railway is being found to work so admirably and successfully in South London, we do not think it is too much to hope that the directors of the District and Metropolitan Railways will, at an early date, again consider the matter in regard to using electricity as a motive power on their underground lines. All who venture a journey on this railway are well aware that it is at the best of times most unpleasant. In the winter it is frequently exceedingly disagreeable, while in the hot weather of the summer, the line becomes practically unbearable, and the air which seems principally made up of a composition of sulphur, smoke and dust gets most objectionable, and does not tend to incline would-be passengers to travel by the underground line when there are other means of reaching their destinations. If electricity were adopted instead of steam, the atmosphere would become vastly improved, although perhaps it would not bring about all the improvements which are at present necessary for the accommodation of travellers. At any rate, the air would be purer and cooler, and these two points are a great consideration on a warm day. As long, however, as steam is used—which must always necessitate coal-dust and sulphurous smoke—we believe that the number of persons objecting to the underground lines, will exceed that of those prejudiced against the use of the electric railway, the prejudice of the latter arising merely because it is (to them) a new invention, or from some other trivial objection which might be removed by a short personal experience.

NOTES ON MICROPHONES.

By G. BINSWANGER.

THE monopoly in telephones which has existed up to the present date has prevented electrical engineers in England from manufacturing microphones and inventing improvements which are felt to be necessary to meet the demands of the English market, mainly on account of the climate, which differs materially from that of the United States or of the continent.

The forms of microphones which have been and are imported into England from abroad are generally constructed in the same manner as they have been constructed and found useful for many years in other countries.

The forms of microphones made abroad may be divided into three distinct categories:—First, the single contact; secondly, the multiple pencil contact; thirdly, the powder or ball contact.

The first form is mostly represented by the Blake type which requires a spring adjustment. This form has many advantages, yet a spring contact requiring frequent adjustment is not to be recommended to the general public.

The multiple carbon pencil contacts, such as the "Gower Bell" and the "Ader," require more than one cell for their proper working, and the diaphragm has to be placed in a slanting or desk form. To obviate this, Continental manufacturers have made microphones with only two or three pencils and in a vertical position; but this disposition of the pencils requires for clear articulation without break, the use of some breaking or damping arrangement, which has been generally supplied in the form of springs, felt, India-rubber, bristles, or other elastic material.

I have found by experience and experiments that this form which might work properly on the Continent is not suited to the humid and constantly changing English climate, because the springs, made of felt or of similar material, being influenced by humidity often loses part of its tension, and microphone carbons adjusted in this manner will give intermittently bad or good results, varying according to the dryness or humidity of the atmosphere. Messrs. Binswanger and Coates, of the General Electric Company, Limited, have patented a microphone which has the advantage of the vertical form of diaphragm, and also that of being worked to the best advantage with a single cell.

The diaphragm is clamped to the box by means of two brass clamps without the use of India-rubber. The carbon tension regulators consist of two blocks and two pencils, as shown in fig. 1; the blocks are so made that they are clamped to the diaphragm by one screw only, and present an angle of about 45° to the vertical form of the diaphragm, the latter being set vertically.

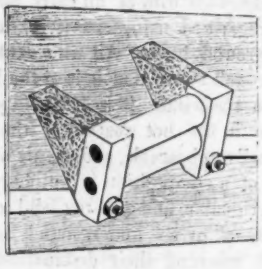


FIG. 1.

The space between the carbon blocks and the diaphragm is filled by cork and forms an adequate damping arrangement not influenced by atmospheric changes or by the vibrations, such as, for instance, those caused by passing trains.

Owing to the disposition of the carbon pencils upon the blocks in the form described, the vibrations of the diaphragm are transmitted in such a manner that the loose carbon pencils are influenced by gravity alone, and the rolling effect of the pencils causing that burring and indistinct articulation of pencils in a vertical position, is entirely obviated. This position of the cork damper, together with the fact that the vibrations are transmitted from the diaphragm to the carbons by means of two screws only, fixed almost in the centre of the diaphragm, allows the vibrations of the diaphragm ample play and full force, so that speech is reproduced not only very clearly but with loudness.

From this description it will be seen that this microphone is a distinct improvement upon the forms hitherto used,

requiring no regulation whatever, and it is claimed that external influences will not affect its speaking power.

A number of railway companies have found these advantages suitable for their purposes; the illustration shows a set specially designed with long distance relay for the bells for use in signalling on railways.

DESCRIPTION OF THE ELECTRICAL WORKS OF THE TOWN OF TRENT, AND OF ITS TECHNICAL AND FINANCIAL RESULTS IN THE FIRST YEAR OF WORKING, 1891.

[FROM OUR OWN CORRESPONDENT.]

THIS description has been published for the International Electro-technical Exhibition at Frankfurt-on-Main.

1.—*Technical System of the Installation.*

1. Water course:

The water power = 600 effective H.P., is taken from the Fersina Brook which yields 700 litres water per second with a utilisable fall of 86 metres. The water is taken above the embankments of the Pontalto Valley. There is a channel 850 metres in length executed in a tunnel, two settling and storage tanks, a double cast iron pressure pipe 860 metres in length and 650 millimetres in diameter. The distance from the water supply to the machines at Ponte Cornicchio is 1,750 metres.

2.—*The Electrical Machine Station at Ponte Cornicchio.*

Six Girard turbines with a horizontal shaft, each of 140 effective H.P., 250 turns per minute, directly connected with the same number of continuous current dynamos of Siemens and Halske's type I, each of 160 ampères and 500 volts. There are the necessary appliances for measurements and for safety; a workshop for repairs with an 8 H.P. turbine, a running crane able to lift 3,000 kilos, a warehouse, habitations for the staff, and a telephone communicating with the upper reservoir, and the equalisation station in the town hall. The distance from the machinery station to the equalisation station is 1,200 metres.

3.—*The Equalisation and Reserve Station.*

At the town hall, along with the offices for management, there are two equalising machines, a battery of accumulators as a reserve during the hours of maximum

consumption and for furnishing current without the use of dynamos on Sundays, holidays, &c., and stores for materials.

4.—*The Electrical Leads.*

Tension in the net 440 volts; tension of glow lamps 110, of arc lamps 55 volts, of electro-motors from 110 to 440 volts. Five-lead system with radial feeding and ring conductors, 10 distribution boxes. In the inner town lead cables by Siemens and Halske with double sheet iron coating, in the suburbs open leads, in the houses lead cables bedded in gypsum. The conductive net for 800 H.P. is laid in all the streets of the town and suburbs at a mean distance of 900 metres from the central. The greatest distance at which current is delivered is 1,400 metres from the central, and 2,600 from the machine station at Ponte Cornicchio.

Tariff for Consumption.

For public lighting the town treasury pays the electric department 10,000 florins yearly, the same as was formerly paid for gas and petroleum lighting.

The charge for private lighting is 50 kreutzers yearly for each normal candle in glow-lights from 5 to 35 normal candles; 7 florins yearly for each ampère used in arc-lights. For electro-motors, 20 florins yearly for each horse-power, measured at the turbines, or about 33 florins yearly for each effective horse-power at the electro-motor.

Consumers have to bear the expense of installation and repairs, glow-lamps, and carbons. The sale of glow-lamps and carbons, the execution of new installations and repairs are the monopoly of the town. Glow-lamps of 5 to 35 normal candles are sold to the burghers for two florins each, and to working men at one florin. Electro-motors can be obtained by consumers from any manufacturing firm.

Financial Results.

Total cost of the installation 650,000 florins. Service began June 1st, 1890.

1. Present consumption:

a. Public lighting. 22 arc lamps of 9 ampères burn in winter during Sundays and holidays; in summer every day to midnight; 560 glow-lamps of 16 to 35 normal candles burn every night.

b. Private use. 30 arc-lamps at 6 ampères; 6,000 glow-lamps at 5 to 35 normal candles; mean illuminating power, 12 normal candles. 30 electro-motors of $\frac{1}{16}$th to 50 effectual horse-power with a total of 200 horse-power, measured at the turbines.

Remarks.

The town has a total of 22,000 inhabitants, including 1,900 soldiers. The public electric lighting is three times as great as the former lighting with 190 gas-burners and 40 petroleum lanterns, which also cost about 10,000 florins. The gas-works were opened in 1859, and their maximum consumption in 1890 was 190 public and 1,900 private burners. At present the gas-works have still 100 private burners and about 20 cooking ranges with a consumption of about 80 cubic metres of gas daily.

Financial position.

RECEIPTS.	Florins.
From the town, public lighting	10,000
„ consumers, 70,000 normal candles at 50 kr.	35,000
„ 30 arc lamps, about	1,500
„ 200 H.P. at 20 florins	4,000
„ profit on lamps and carbons	6,000
„ interest on installations	2,000
Total receipts	58,500

EXPENDITURE.	Florins.
Interest on capital sunk at 4½ per cent. ...	29,000
Technical service, &c.	5,400
Management	3,000
Cost of maintenance and unforeseen expenses ...	11,100
Total outlay	48,500

Net profit, florins, 10,000, which overplus is to be used as a sinking fund for half the capital sunk.

Probable service in the future:—Several new installations are already in hand, and others are being negotiated so that the private consumption will probably rise in a short time to 100,000 normal candles in glow lights and 300 electromotive H.P. The private consumption can reach a maximum of 130,000 normal candles in glow light and 500 H.P. since the battery of accumulators can be charged from 11 p.m. to 5 a.m.

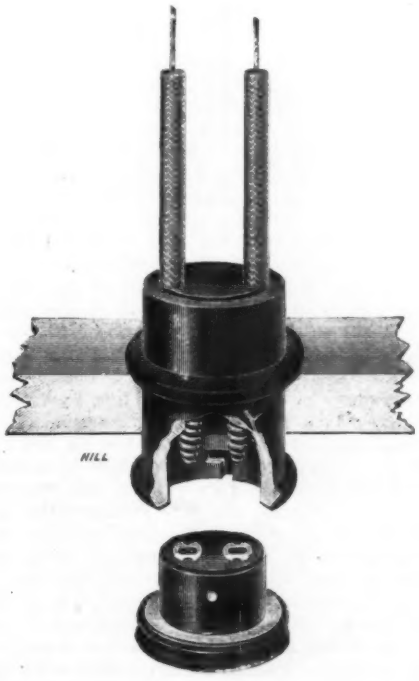
The result is good, because each effective H.P. at the turbines furnishes 150 normal candles, even at the most distant points of consumption, and a useful effect of about 60 per cent. in the electromotors. Each effective H.P. at the turbines gives at least 200 normal candles in glow lamps and effective H.P. in electromotors if we consider that even during the hours of maximum consumption not all the lamps are burning at once, and the electromotors according to agreement are disconnected at this time.

The tariff for consumers is exceedingly low, which has a very beneficial effect on the small trades of the town. There is a sanitary benefit since the electric light is superseding gas and petroleum lights, both in public establishments and private houses.

NEW VITRITE CHEMICAL LAMP HOLDER.

OUR illustration shows a lamp-holder which has been specially designed for use in chemical works, starch factories, underground tunnels, and all places where sulphurous and other fumes are present. These fumes, it is well known, rapidly destroy metal fittings; and those who have had much experience with electric light installations in these impure atmospheres have not found reason to be perfectly satisfied with any of the numerous types of holder which have hitherto been introduced for use under these conditions.

The vitrite chemical holder entirely protects the metal lamp connections from any contact with the outer atmosphere. A special form of vitrite cap is supplied with the holder, which is sent to the lamp manufacturer when ordering, for affixing to the lamp. A small rubber ring is placed on the



cap, which then fits quite tightly into the holder, the rubber washer rendering the joint airtight. The connection to the spring of the holder is made in the material of the holder itself, and the piece of insulated wire attached to the holder affords opportunity for making a proper insulated joint with the permanent connections of the installation. The arrangement of the spring in the interior is exactly similar to that in the ordinary form of vitrite holder. A rim is arranged round the top of the holder to allow of its being supported

if desired, by resting in a hole bored in a piece of wood or other fixture.

Messrs. Woodhouse and Rawson United, Limited, have stocked a large quantity, from which they can supply all requirements.

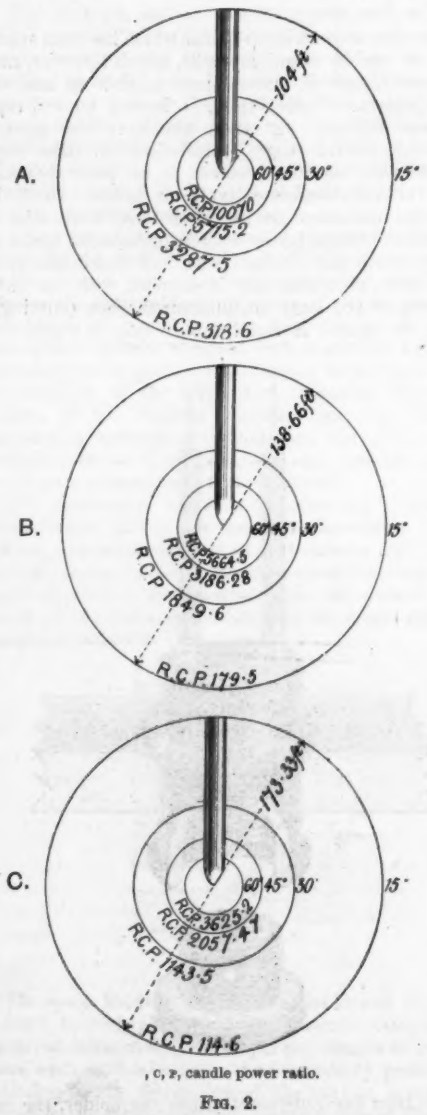
PRACTICAL PHOTOMETRIC RESEARCH.

BY RALPH CONRAD RICHARDS.

(*Continued from page* 270.)

PART III.

IN the case of fig. 2, it should be remarked that the three figures, A, B, and C, represent the distribution of light from arcs, the respective pole heights being 15, 20, and 25 feet; it will thus be seen, on taking the instance of any particular ray, that the point where it meets the ground becomes more distant from the light source the higher the latter is placed; in any case, except, perhaps, under extreme and peculiar



, C, P, candle power ratio.

FIG. 2.

circumstances, it is not advisable to exceed an elevation of 30 feet. In practice, from 20 to 25 feet is a good position; but, of course, this cannot be cited as a fixed and undeviable rule; where there are many lights it is preferable to decrease the pole height, as the dilation of the pupil, due to the general increase of illuminative power, is in this case proportionately greater.

The author does not advocate milk glass or frosted globes, on account of the enormous absorption of light, which in the case of the former sometimes reaches as high a figure as 60 per cent., whilst in the case of the frosted glass, the average percentage of absorption is about 30. In the following table the absorption of various materials is given, from which the extravagance of the prevailing method should be rendered apparent.

TABLE II.

No.	Substance.	Percentage.
1	Ground glass about $\frac{1}{10}$th inch thick, very uniform in grain	25 or 26
2	Ground glass, same thickness, medium grain	25 or 26
3	Ground glass, very coarse	about 30
4	Opal glass (glass rendered opaque with stannic oxide), fairly transparent ...	40 to 42
5	Opal glass, very opaque	57 to 60
6	Thin cup of Coalport china	about 95
7	Solution of plumbic acetate, appearing to the eye of about the same transparency as No. 4	37
8	Solution of milk in water, ditto	43
9	Solution of calcic carbonate, ditto	20 to 55

Thus it will be observed that a fine or medium grained ground glass is preferable where it is absolutely necessary to resort to globes, both on account of the low percentage of absorption, and also for another reason, which has not (in so far as the writer's knowledge extends) received attention; all who have attentively observed an arc lamp furnished with a globe, whose characteristic is about that of No. 4 in the above table, will have noticed the peculiar reddening of the arc, and also, to a much lesser extent, of the diffused light itself, which cannot be due to the fact that the light partakes of this colour, for viewed by the naked eye alone, an arc appears to be of a vivid bluish-white colour. In the case of very thinly stannised glass, such as that used in the globes of the Brockie-Pell lamps, this change is not so far advanced; but even there the predominating tint is a pale yellow, the almost exact counterpart of the usual appearance of the sun, which is really a pleasant alteration. The only reason by which the writer can account for this strange alteration in colour, by transmission through what, when viewed by reflected light appears to be white glass, is the presence of selective absorption, which modifies the colour of the rays in much the same manner (although on a much reduced scale) as London fog.* It was for the purpose of seeing whether this is so, that the three solutions, 7, 8 and 9, were taken. In the case of the first two (Nos. 7 and 8), the appearance was strikingly similar to No. 4 when the requisite dilution was effected, but contrary to the glass (which re-whitens the hue or tint of the light when the oxide is present in greater quantity), the solution in question passed from yellow through orange to a deep brownish red when viewed by transmitted light (the amount of foreign matter being gradually increased meanwhile). No. 9 exhibits no such absorption, the light being simply dispersed and absorbed as in the case of ground glass; the abnormally high figure of this solution was very probably due to the large amount of chalk used, for it is impossible to exactly match the appearance of the glass with a certain addition of chalk, as in solutions 7 and 8; for on doubling or even trebling the amount in solution, the appearance is not altered, the solution appearing unchangeably white; the very low percentage figure which the smallest degree of concentration gives, is, in the writer's opinion, a powerful argument for the absorption theory. The great disadvantage due to employing an opal glass globe is, that if it be desired to make the glass so poor in stannic oxide that the transparency (or, more correctly, translucency) be greater, this very increase in transmitting power is merely the means of introducing that evil which it is employed to overcome, viz., the direct transmission of rays from the arc, with lack of dispersive power. Finally, then, the writer would wish to impress upon all arc lamp manufacturers the very great de-

* That is, by absorbing a greater percentage of blue than of red rays.

sirability of using only those globes which completely hide the arc from view; opal or milk glass is, for the reasons already stated, inadequate for this purpose without the attendant disadvantage of inefficiency; surely, if in an otherwise efficient installation it is worth while to employ engines and dynamos of the highest obtainable efficiency, and leads of the best conductivity and insulation resistance, it is not too much to expect that the rest of the plant should be as efficient as possible. When it is remembered that no one would think of using plant giving as low a percentage of the power put into it as 30, it will be seen that the almost universal employment of opal glass for lamp globes is about as great an absurdity as one can well instance; and it is extremely questionable whether there is yet upon the market a perfect arc lamp in this respect. Elaborate figures are given, some manufacturers persisting that their lamps yield as high candle-power as 2,000 per 500 watts, what does this mean? The figures given are plain, and equivocacy seems impossible; so that it is to be assumed, apparently, that four candles are obtainable with the expenditure of one watt.

Unfortunately, as each maker uses his own system, no common standard of comparison can at present be agreed upon, and although it *might* be possible for this high rate of efficiency to be obtained, yet this would only be the case with a clear glass globe; it is therefore not too exacting to condemn the practice of palming off the naked light candle-power as the power obtainable with a globe either of milk, opal, or ground glass.

The only really reliable source of information is to be found in the published tests carried out at exhibitions, where every lamp is placed under similar and equal conditions. Such a series of tests was carried out, as is well known, several years back at the Philadelphia Exhibition. These are among the most reliable on record, and were the most systematic in all respects. The light standard consisted of an Argand lamp, furnished with a Methven screen, and the photometer was of the Bunsen type, but having the revolving screen arrangement. This latter consisted of a similar apparatus to that described in the second of these articles (ELECTRICAL REVIEW, March 27th), viz., two sector discs, capable of presenting any aperture, and revolving at such a speed as to cause no perceptible waver in the light. These intercepted the rays from the lamp under examination, and could be approximated to any required interception. Measurements were made by noticing the required adjustment necessary to balance the effect of the standard.

Table 3, which is a modified abstract of the report of the commission, gives the results of these measurements:—

TABLE III.

Lamp.	Volts.	Amps.	Watts.	H.P.	Average candles per H.P.
Arago	39·87	15·44	614·4	·824	562·6
Ball	48·83	6·60	322·3	·432	833·4
Brush	52·50	6·62	347·5	·466	763·2
Brush	56·73	10·32	585·5	·785	1194·6
Diehl	31·84	17·67	562·6	·754	864·8
Richter	30·00	20·19	605·7	·812	855·0
Van de Pœle	37·88	16·91	640·5	·858	1005·8
Van de Pœle	45·77	13·31	609·2	·817	839·8
Western Electric	25·74	17·89	460·5	·617	415·2

From these tests it will be seen how great is the disparity when compared with some advertisements concerning lamps. To the writer 1,000 C.P. does not seem at all a poor efficiency for 1 H.P., when everything is taken into consideration. Much as has been said about the improvement in arc lamps few will doubt the truth of the above figures. Makers have certainly succeeded in placing steady and reliable lamps upon the market, but as yet little or no improvement has taken place in any other respect.

It is of course unnecessary to consider the measurement of semi-incandescence lamps. Regarding the incandescent method of illumination there is much to be said, both on the side of efficiency and colour. The former will be dealt with separately; the latter has but little in connection with the present subject (except, perhaps, the one or two facts connected with the alteration in colour of the light radiation due to age). The writer had two small incandescent lamps for the purpose of experiment. In the first place, one lamp was connected up in circuit with a 10-cell Daniell's battery, and a very bluish light obtained; in fact, the light partook far more of the character of the arc than of the incandescent light in colour; this was, of course, a sure sign that the lamp was over-run, but as the object was to produce as much disintegration as possible, this was of little consequence. After a run of six hours the filament broke down, but not before it had been observed that the lamp gradually decreased in the blueness of its light radiation, until it became a whitish-yellow in colour. As the cells were well supplied with cupric sulphate, and sulphate of zinc was used in the porous pot, the amount of energy supplied to the lamp did not decrease; and, moreover, three tests were made roughly measuring the current and resistance, which was almost identical in each case. The second lamp, which was of the same size as the first, was then coupled up in circuit and the broken lamp removed; the light given was as before—bluish-white—but on intercepting the second lamp and viewing the light through it, the colour appeared the exact counterpart of that given by the first lamp at the time of its breaking.

It seems, therefore, probable that the real cause of the deterioration of the incandescent lamp is merely a question of the blackening of the globe. The disintegration which occurs in all lamps should tend to improve the efficiency, as it must increase the specific resistance and decrease the radiating surface.

The writer has not yet observed the case of any lamp which has deteriorated while its globe remained clean.*

(*To be continued.*)

SOME NOTES ON THE RESULTS OF THE PARIS TELEPHONE LINE.

BY G. L. ADDENBROOKE.

THERE is much that is interesting in Mr. Preece's paper read before the British Association on the Paris Telephone line and reproduced in your issue of August 28th, for besides the success which it chronicles, it is an endeavour to import order and method into experiments with telephones.

Now that all the world may use telephones, it is probable that attention will be directed to the subject, and attempts made to improve on existing patterns. How far this is possible remains to be seen, but I am afraid that old telephone men, remembering the numberless negative results of the past, will not be very sanguine, and it seems likely that unless some one is fortunate enough to strike quite new ground, improvements are rather to be looked for in matters of detail than in any great modifications of existing apparatus.

To experiment with telephones effectively, requires a good deal of skill, unwearying patience, and a great amount of practice. For, since at present we have no instrument or set of instruments by which we can gauge telephonic results, the observer's ears and memory are the only available criteria taken in conjunction with the speaker's voice at the other end of the line. Now it is by no means easy to always speak in the same voice, with the same intonation, and with the mouth so placed and directed that the effect on the diaphragm of the transmitter is always the same. A good deal, too, depends on the language chosen; common rhymes are known to the listener and are undesirable, because he has a difficulty in distinguishing between what he hears, and what he, knowing what is coming, is prepared to

* Subsequently to writing the above a friend (to whom he had mentioned the circumstance) brought three lamps to the writer; these, he stated, had each remained in series for over 1,000 hours, the globes, notwithstanding, remaining perfectly clear; although, contrary to the writer's experience, the light had deteriorated in the usual manner. One lamp was opened at his suggestion and microscopic examination revealed a very irregular and broken filament; hence, in this case, it is thought that the cause of deterioration is to be found in an increase of radiative surface—which more than counterbalanced the rise in specific resistance, the lamp therefore gave less light owing to the smaller elevation of temperature by a given current

hear; on the other hand, involved sentences should not be used, but remarks of a conversational character. Again, the listener must carry in his memory for some time the comparative loudness and clearness of sounds, an act needing precision and close attention.

For these reasons, anything which helps to enable predictions to be made of the telephonic state of a line, and the apparatus at the ends of it, by means of ordinary electric tests is a great advantage.

Mr. Preece's formulæ render valuable aid in this direction, but there is an important point to remember in connection with them, and with experiments on telephones generally which is often lost sight of, and which, borne in mind, accounts for much which is otherwise puzzling in their action. This is that the effects of the instruments themselves should never be lost sight of. In calculating the energy which an alternating current dynamo would send into a circuit if driven by a given horse-power, we should want to take into account the resistance and self-induction of the armature, and we must do the same in telephony, only in this instance it is of far more importance.

To apply this to the Paris line, Mr. Preece informs us that the resistance (C R) is 693 ohms. Now if two complete sets of telephone instruments are in circuit at each end, they themselves would have about the following resistances :—

2 telephones at 70 ohms each	...	= 140 ohms.
2 transmitter coils, 250 ohms each		= 500 „
Total	...	... 640 ohms,

or approximately be equal to the line itself, supposing no indicators are left in the line. From this it will be readily seen how little difference distance or C R alone makes. In this case if the length of the line were doubled, provided it was a first class overhead one, it is evident that the loudness of reproduction of speech would be reduced, not by one-half, but by one-third, nor would even such a reduction as this take place in reality, because the telephones and transmitter coils themselves which are joined in series at each end, have a large self-induction which, taking an average rate of vibration for the voice, can be taken as so much added resistance. I have not, unfortunately, by me at present the means of arriving approximately at what this self-induction is, but from what we know of the self-induction of other apparatus of similar construction, it must amount to a considerable figure. Here then are sufficient reasons to show why it is so little good testing telephones by the aid of a resistance box and why considerable alterations in resistances only make so little difference in the clearness or loudness with which speech is transmitted, why in fact on a good overhead line it is so difficult to tell whether one is speaking through ten or a hundred miles.

Mr. Preece is certainly right in taking the self-induction of a double circuit copper overhead line as negligible, but it must not from this be concluded that there is no self-induction in the question for there is a great deal in the instruments, some of which can if necessary be eliminated. If a person is speaking in London to Paris his receiver is for the time being useless, in fact is just so much resistance and self-induction added to the circuit unnecessarily, at the same time the listener in Paris has no immediate use for his transmitter coil which also interposes its resistance and self-induction. These useless members can be short circuited or cut-out for the time being by the aid of a suitable key with considerable gain to the talking powers of the line, only, unfortunately it requires an amount of practice to use such a key which is beyond what can be expected of the general public.

As regards the third factor in the question, namely, capacity, this is but small in the instruments themselves, and therefore capacity in the line has an effect on the reproduction of speech in all cases in direct proportion to its magnitude.

That commercial speech has been attained with a capacity of 10 microfarads in the line is very satisfactory, since it shows that with double wires and the use of insulating materials of such low inductive capacity as are now obtainable, telephony may be attempted with confidence over as large an area as the United Kingdom, including a reasonable proportion of underground wires in towns and in passing through railway tunnels.

ELECTRICITY IN NEW SOUTH WALES.

[FROM A CORRESPONDENT.]

THOUGH perhaps the amount of actual electrical work done in Sydney is not very great as yet, still the subject is always cropping up in one way and another in the papers, which serves to keep it well before the public eye. The new Parliament should have some sort of a knowledge of the fact that electric lighting, at least, is coming to the fore, as there are no less than seven electric supply and other Bills on the list for presentation at the ensuing session. First and foremost, of course, will come the Government Electricity Controlling Bill, which has been for a long time in the hands of the Parliamentary draftsman, and which was to have been presented at the last Parliament. Next comes the City of Sydney Municipal Bill, in which the City Fathers will apply for permission to not only light the streets but also to retail electric light and power to city residents. Then come the Gas Company's Bill, and three private Bills, one emanating from the Brush Electrical Engineering Company, one from Messrs. Harrisson and Whiffen (the Crompton Electrical Company), and one from the Electrical Material Company. All these are for Sydney. In addition to these, the Council of the Borough of Newcastle are also applying for powers to light the streets and public places of the said borough with the electric light, and to supply electricity within or without the limits of the said borough.

With regard to the Gas Company's Electric Lighting Bill, I fancy there will be a considerable difficulty in getting it passed, even though it was the first in the field. The suburban municipalities have, almost without exception, passed resolutions to the effect that they would oppose the Bill. Moreover, there is a very strong labour party in the Legislative Assembly, which is nearly sure to be averse to a large private monopoly, such as this would be. There will not be, I fancy, any opposition to the Newcastle Municipal Bill.

Another suburb—Strathfield—has been added to the list of municipalities which are considering the important question of electric lighting, and at a recent meeting it was decided "that Messrs. Wood Bros." (the contractors for the Enfield, Moss Vale, and Burwood electric light plants) "be asked to supply the Council with full particulars and cost of introducing the electric light for street lamps."

An application was made a few days ago to the Windsor Local Land Board by Messrs. Masters and Macartney, representing the Australian Rights Purchase Association, Limited, of which they are directors, for the right to divert the water from Grose River into a race, by constructing a weir across the river at a point about three-quarters of a mile above its junction with Barralen Creek. This will give an effective fall of about 100 feet, at a point just above where the river ceases to be navigable for small boats. The great power which is now going to waste will be used by means of turbines and dynamos to generate electricity for the purpose of lighting Windsor, Penrith, Richmond, and other towns, as well as providing motive power for factories which may be established in and around the neighbourhood. The initial cost is estimated at £23,000, and the total cost at £70,000. The board recommended "that a site for machinery be based at a rental of £10 *a year*, such site to be defined by survey, and not to exceed *three acres*. We also recommend that a site for a dam be granted, at a point to be defined, at a rental of £10 *a year*, under such terms and conditions as may be decided." This seems very good value for £20 a-year, and should be a profitable undertaking.

Affairs at Broken Hill have been somewhat disturbed lately. The Municipal Council, wishing to have some expert opinion as to how work was going on, called in a Melbourne firm of electrical contractors, Messrs. Booth and Ellson, instead of appealing to an independent consulting engineer. Messrs. Booth and Ellson presented an unfavourable report, more especially upon the overhead wiring, and the contractors for the work, Messrs. Westcott, Marshall and Adams, were accordingly communicated with. Mr. Hitchcock, a Westinghouse expert, who is superintending engineer to the contractors, in replying, affirmed that the condemnatory report was written for interested motives. He states that the cable is especially adapted for the Barrier

climate, and that for safety and durability it is superior to many other cables in use for the same work in other parts of the world. As the cable in question is "Callender's," a brand which already has a firmly-established reputation in the colonies as elsewhere, Mr. Hitchcock certainly seems to have good foundations for his assertions.

At Young, the council have just found out that they have been charging too low on expenditure for lighting, and consequently have had to economise. The first step was to shut down the whole plant after midnight. A consequence of this was that the pillars throughout the principal thoroughfares have had to be removed. These pillars were erected on concrete pedestals at the intersections of the principal streets, and carried a cluster of lamps, and were a noticeable feature of the street lighting; but as the lamps will not be lit after midnight, the removal of the pillars was looked upon as necessary, seeing that all vehicular traffic would be exposed to danger by the darkened obstruction of heavy concrete blocks.

Amongst the installations completed and started running during the past month may be mentioned the Australia Hotel, the Imperial Arcade, and the wharves and offices of the A.U.S.N. Company and the Tasmanian S.N. Company. The Australia Hotel, the contractors for the lighting of which were Messrs. H. H. Kingsbury & Co., is quite the swagger hotel here now, and has a very handsome installation of the electric light, the chief point about it being the fittings, which are entirely of local manufacture. The designs, which are in hammered iron, brass, and copper, have been based on the Australian flora, such as the waratah, bottle-brush, &c. The brass and copper work has all been done in Messrs. Kingsbury's workshops, and the iron work by two Sydney firms, Messrs. Castle and Richards, and I doubt if even Messrs. Benham and Froud, Verity or Faraday, could surpass these fittings, either in finish or design.

The hotel is lit by about 700 16-candle-power incandescent lamps and two 55-volt Brockie-Pell arc lamps run off the incandescent circuit. In addition to these, which are for the inside of the hotel, there will be two handsome bronze statuettes on the kerbstone immediately facing the entrance, to carry a cluster of incandescent lamps. The lamps are run from two No. 7 Manchester dynamos, giving 350 ampères at 110 volts, each driven at 770 revolutions from countershafting driven by Fowler's horizontal compound engines. There are three engines all connected to the main countershaft, from which power is given to the pumping plant for the hydraulic lifts, freezing machinery, &c., as well as to the dynamos; consequently, after midnight, a No. 5 A Manchester dynamo, giving 80 ampères at 110 volts is used driven by a separate engine. A prominent feature of the installation is a mast, carrying two 2,000 candle-power Brockie-Pell arc lamps erected on the top of the dome of the hotel at a sufficient altitude to be seen far and wide. There are three Manchester motors used for ventilating purposes for the engine room, kitchen, &c.

The Imperial Arcade has a very nice arc and incandescent plant which has been installed by the Williamson Electrical and Engineering Company. It consists of 14 Thomson-Houston arc lamps, run from a Thomson-Houston arc dynamo and 450 incandescent lamps, 16 candle-power, run from a Manchester dynamo driven by a 60 H.P. double cylinder, high pressure horizontal Marshall engine, with multitubular boilers. There is also a duplicate set of engines and dynamos in case of a breakdown.

The wharves and offices of the U.S.N. Company and Tasmanian S.N. Company are lit from a miniature central station erected for the purpose by the Electrical Material Company. The plant consists of a 75 H.P. engine of the marine type driving a 25-light Brush arc dynamo and a 10 kilowatt Mather and Platt incandescent lamp dynamo. At present there are only seven arc lamps and about twenty 16 candle-power incandescent lamps installed. An amusing feature of the opening of this installation was the way the newspapers announced it; one paper in particular, which appeared to be labouring under the delusion that it was the first electric light plant installed in Sydney, waxed eloquent to the extent of three columns. Another paper fancying that it was complimenting Mr. Hamilton, the Electrical Material Company's electrician, stated that the plant "took several months to erect."

The Brush Electrical Engineering Company have already got a footing, and bid fair, under Mr. Oswald Haes's superintendence, to have a big say in electric lighting matters. Already the Brush Company have in hand the lighting of a large addition to Messrs. Hordern's (the Sydney "Whiteley") premises, and a private installation in Adelaide, and have just completed the lighting of the Railway Parcels Office at Redfern.

A splendid slate bed has been discovered at Mintaro, in South Australia, and the slate from it has proved to be excellent for switchboard purposes, and takes a beautiful enamel.

The Brush Company are having a large switchboard 5 feet by 4 feet made of this slate for the installation they are putting in a Mr. Waite's residence in Adelaide.

SAFETY MINING CABLE.

THE use of properly protected electric motors has now become a recognised means of transmitting power even in fiery mines, but many colliery managers still object to the introduction of electricity into their collieries, owing to the possibility that exists that the cable may be broken, by falls of roof or stone, or by the tubs leaving the rails and tearing down the cable, and thus setting fire to the timbers or firing the pit. With a view to altogether removing this source of danger, Messrs. W. T. Goolden & Co., Woodfield Works, Harrow Road, who for some years have made electric mining machinery a speciality, are introducing a safety mining cable invented by Mr. L. B. Atkinson.

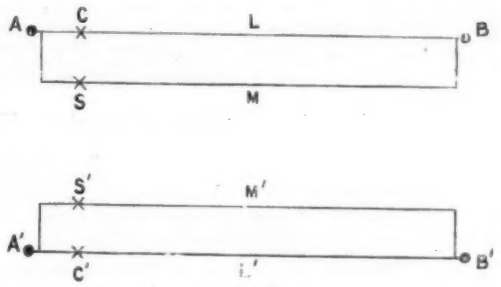


FIG. 1.

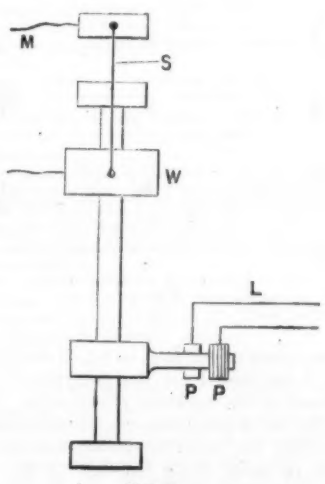


FIG. 2.

The diagrams and figures, with the following explanation, show the principles on which the cable is constructed:—In fig. 1, A A′ are the two poles, say, of the generating dynamo, and B B′ are the two poles of the motor or lamps. These are connected each by two wires, a main conductor, L, L′, and a subsidiary conductor, M, M′. These wires will, of course, carry current simply in proportion to their areas, being of

the same length. Now, in each main and each subsidiary conductor are arranged cut-outs proportioned to the carrying capacity of each wire. Suppose the main conductor, L, be broken, provided that the subsidiary conductor, M, is not broken, no spark will result at breaking, as the circuit is still closed, but the whole current now traverses the subsidiary conductor, and the fuse at once melts. This fuse allows a weight to fall (see fig. 2 where W is the weight, and P P the switch), and this instantly disconnects the whole circuit. This, then, is the principle.

The practical form of cable to carry this into effect is shown at fig. 3. A close wound spiral of tinned copper wire,

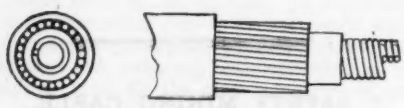


FIG. 3.

several wires being for preference arranged in parallel, is braided over, but not heavily insulated. Over this is laid a stranded conductor of the required area, and this in turn properly insulated in any of the usual manners. If the cable is torn down from the roof or broken in any way in tension, this inner conductor extends to an indefinite extent, for as it gets drawn out the diameter of the spiral decreases, and hence it becomes quite loose in its tube. This spiral conductor carries the current for an instant till the fuse breaks, when the whole conductor is disconnected from the supply.

It sometimes, however, happens that a cable may be cut in two by a falling stone, or even by a sharp instrument like a knife or axe.

By a small addition to the arrangements already provided this also leads to an instant disconnection of the circuit before it finally breaks, and hence without spark at the point of rupture.

Fig. 4 shows the cable thus broken and extended. Fig. 5

FIG. 4.

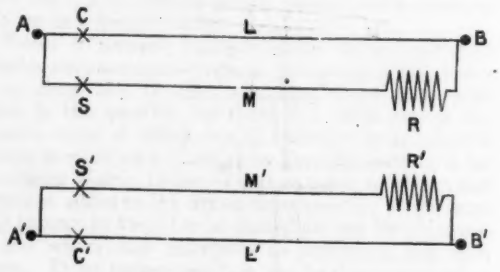


FIG. 5.

shows an arrangement similar to fig. 1, except that at the further end of the cable from the generator is a resistance, R, in the circuit of the subsidiary conductor. The effect of this is that the fall of potential along the subsidiary conductor is less than along the main conductor, and that, therefore, a difference of potential exists between them. If, therefore, the cable is damaged by falling stone bringing the inner and outer conductors into contact, or if the cable be cut by a metallic instrument effecting the same result, there is an immediate increase of current in the subsidiary conductor, thus melting its fuse and disconnecting the cable as before. This cable, therefore, really acts by transferring the electrical rupture of the cable to some point such as the switchboard at the top of the pit where it is unimportant, thus making its use safe under all circumstances.

Apart from colliery work, the use of this cable would be desirable for overhead high tension wires, as if broken the broken ends would not be left in the road with the current on, and thus would not be left a source of danger to persons and animals in the street.

A NEW FORM OF PENDANT.

THE sketches show an improved form of pendant, designed by Mr. Malcolm Sutherland, electrical engineer to Messrs. William Denny and Brothers, Dumbarton. Fig. 1 shows the complete fitting; B, B, is the wooden back block, made of teak, boiled in paraffin, to which the junction box, J, B, is attached. The wires are led in through water-tight stuffing boxes, and attached to the screwed junction, J. The stalk of the lamp, S, is then screwed into its place, making contact with the junction, J. Then the ornamental cover, O, C, is screwed hard up against the wood, jamming the stalk, and preventing it from getting loose. To prevent the cover from slacking back two screws are driven through the flange into the wood. G, C, is the usual Edison-Swan globe carrier. Fig. 2 shows the upper and lower ends of the stalk, S. J, B, C is the junction box cover, which is permanently attached to

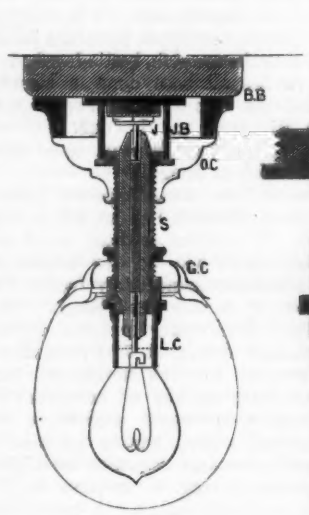


FIG. 1.

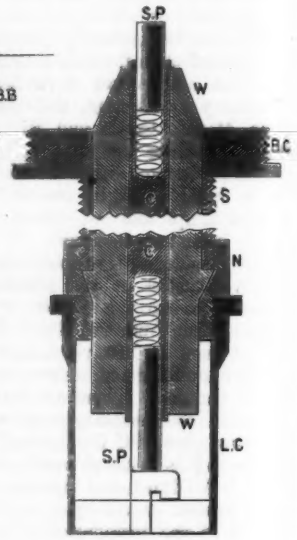


FIG. 2.

the stalk. C, is a rod of brass, which forms the lead, the return being the stalk and junction box. W, is the insulating material, also formed of hard wood boiled in paraffin. The upper end of this is tapered to prevent moisture from lying across the end, and causing a short circuit. A spring plunger is attached here to ensure good contact. To prevent the possibility of an arc being formed, in the event of fitting getting loose, the plunger is made so long that the fitting will fall clear of the box before it breaks contact. In the old form a central contact lamp-holder was screwed into a nipple on the lower end of the stalk. In the new form the wood is carried right down into the lamp-carrier, L, C, and another spring plunger is attached. By this arrangement we have only two contacts instead of three. A small tapered shoulder is turned on the wood, which, being jammed between the end of the stalk and the nipple, N, prevents it from changing its place. This form is now being used by Messrs. Denny for ship lighting.

W. H. Wilcox and Company.—The business of W. Goodwin and Company, 36, Primrose Street, Bishopsgate, which was purchased two years since by Messrs. W. H. Wilcox and Company, has now been amalgamated with the other branches of their trade at 34 and 36, Southwark Street.

CONDITIONS OF COMPETING FOR THE CONCESSION FOR THE ELECTRIC LIGHTING OF THE TOWN OF PISA.

I.—*Conditions for Participation in the Competition.*

ALL the competitors on handing in their tender must submit themselves to the following regulations:—

(*a*) They must declare that they accept all the prescriptions of the accompanying schedule of conditions.

(*b*) They must pay into the Communal Treasury a provisional security of 10,000 lire in cash, or in certificates of the public funds. This deposit will be returned within three months from the conclusion of the competition; but it is forfeited to the town if the party obtaining the concession does not, within three months from receiving such concession, pay in the definitive security (section 26 of the schedule of conditions), or within the same time does not put in an appearance to sign the agreement.

(*c*) The competitors must exhibit any patents which they possess for the production and transmission of electricity, and any certificates proving the successful working of installations which they have erected elsewhere.

(*d*) They must state if, and for how long, they claim the privilege of an exclusive concession.

(*e*) They must state the duration of the concession sought for.

(*f*) They must indicate those streets and other public places where they undertake to put down leads for the electric current.

(*g*) They must mention the spot where the installation for the production of the electric current is to be erected.

(*h*) They must explain whether they intend to fix aerial or underground conductors for the current.

(*i*) They must describe the system which they will employ for generating the current, stating the maximum tension at the clamps of the dynamo and in the leads.

(*l*) They must fix the minimum performance which they engage to furnish within 18 months from the ratification of the concession (see stipulations of Article 24 of schedule of conditions).

(*m*) They must determine the scale of charges for the use of meters on hire and for supplying current to subscribers, the fixed yearly charge, and that for consumption, being laid down in accordance with Articles 15 and 17 of the schedule of conditions.

(*n*) They must state the limit of consumption above which a reduction of the scale of prices must come in and to what extent.

(*o*) They must state the discount (as compared with the charge to private consumers) which they will allow the municipality if it requires a supply of current, whether for lighting or for other purposes.

(*p*) They must give the conditions—both with reference to the date of executing the works and removal of existing leads—under which the acquirer of the concession binds himself, according to Article 21 of the schedule of conditions, to meet the demands of any private person.

It is open to the Town Council to decide upon the tenders submitted without stating their reasons, and to fix on the tender which is preferable in accordance with the conditions proposed as a whole.

II.—*Schedule of Conditions.—Duration of Concession.*

Section 1. The concession will not exceed 30 years calculated from the day when the grant is communicated to the concessionary.

Duration of the Privilege.

Section 2. The municipality is prepared to bind itself for a term of years not further than January 31st, 1903, and which will be inserted in the conditions of the concessions, not to grant to any persons public lands for the purpose of the conduction of the electric current. As soon as this term has elapsed, the concession involves no monopoly or exclusive privilege.

Low-Tension Electric Currents.

Section 3. In case of electric currents where the potential difference between any two points does not exceed 300 volts the concessionary may arrange the leads at his discretion, only such leads must be fixed to points of support which are sufficiently insulated, and where the circuits are within the reach of human beings they must be provided with insulation.

Conduction of High-Tension Currents.

Section 4. For currents in which any two points whatever have a higher potential than 300 volts, all the best and most recent precautions must be adopted (such as automatic cut-outs, safety nets, &c.), so as to protect persons and objects from injury in case of an injury to the leads.

Aerial and Subterranean Leads.

Section 5. Aerial and underground leads may be used in the following cases:—

(*a*) Aerial leads must be for their entire length covered with an insulating layer which must permanently resist the influence of the weather, and which must correspond with a sample submitted for examination to a committee of the council.

The leads must be secured upon insulators which, even in the case of a partial uncovery of the wires, afford security against any contact with the earth.

In case of high-tension leads the supports must in no case be affixed to the front of the houses. The leads must be conveyed over the roofs, and the posts must be so high that no wire is carried at a less height than 9½ metres from the roof or any other part of the house.

In carrying aerial leads over squares or plots where there are no buildings, such leads must not be placed at any point lower than 7 metres from the ground, and the municipality has the right of prescribing more elevated leads at points where they may think requisite.

Where, in order to reach the lamps, a descent must be made from the main leads or at the secondary stations of the transformers or accumulators, the vertical leads passing along the buildings must be enclosed in insulated cables protected by pipes connected with the earth or the masonry.

(*b*) In case subterranean leads are employed, they must be either insulated or protected by a metal casing or carried in pipes of earthenware, according to a plan which must be submitted to the municipality for approval.

The leads must be placed at such a depth from the surface as not to interfere with the paving of the streets.

At certain points places for observation must be introduced, so as to facilitate the detection and the repair of damages.

Public sewers cannot be utilised in laying down the leads, which must by preference be placed underneath the foot-way. An exact plan must in every case first be approved by the committee of the municipality.

Works for Underground Leads.

Section 6. Where underground leads are made use of, all operations which involve a change in the surface of the streets must always be executed at the cost of the concessionary and under his inspection, but by persons selected by the municipality and subject to their inspection.

The concessionary must provide for a provisional thoroughfare in places which he has caused to be dug up.

Compensation to Proprietors.

Section 7. Besides attending to the laws and regulations concerning leads situate near telegraph and telephone wires, the concessionary is responsible for all damages which the owners of houses or land may demand on account of laying down the lines, fixing the supports of the wires, erecting secondary stations, &c., both during the construction of the installation and in course of permanent work. (Under this clause the undertaker of the installation would, in England at least, be subject to vexatious claims.)

Responsibility of the Concessionary.

Section 8. The concessionary is responsible both to the municipality and to private persons for all consequences resulting from the position of the central or the secondary installations, from the system of the machines, of the apparatus employed, and the presence or the requirements of the electric leads; this provision extends also to the acts of his subordinates.

Compulsory Removal of the Leads.

Section 9. In case of public works, of whatever nature, the town reserves to itself the right of removing all existing electrical leads from their place, and it devolves upon the concessionary to put them to rights again in accordance with the new conditions of the locality, and without having any claim for a return of his outlay.

Documents which must be Produced before Executing the Installation.

Section 10. Before the concessionary takes the works in hand he must submit the following documents to the committee of the municipality for approval:—

(*a*) A complete plan of the works to be executed with a tracing of the leads, in which attention must be given to leads, channels, &c., already in existence for other purposes, aerial or underground.

(*b*) A plan of the net, with statement of the dimensions of the leads, and the electrical data of the maximum current admissible in the various wires.

(*c*) A plan in detail of the offices and of the boiler, engine and dynamo houses.

(*d*) A technical plan of the machines with an exact statement of the manner in which the work is projected, so as to avoid all prolonged interruptions.

(*e*) Samples of the leads to be used in all parts of the net, of the supports, of the connection boxes, the fusible cut-outs, and in general of all accessories which will come into use in the course of the works.

(*f*) A complete and detailed catalogue of all the automatic appliances for interrupting the current in case of an injury to any one of the exterior circuits.

The Town Council reserves to itself the right to undertake all alterations which, after examining the above vouchers, it may consider to be required in the interest of public safety, excepting disputed cases provided for in section 28.

Revision.

Section 11. After the operations of installation are completed concessionary may not begin the service until the municipal committee, after a special revision, have granted him permission. The municipality may, in this revision, demand, at the expense of the concessionary, all proofs which they think necessary, in order to satisfy themselves that all the stipulations of the agreement have been observed.

Drawings, Plans, and their Alterations.

Section 12. After the execution of the works the concessionary is bound to send in to the municipality a plan of the conductive net on the scale of 1 : 1,000, in which all the ramifications leading to the various houses, and a statement of the watts which they convey are laid down, and to keep such a plan ready in his offices.

The concessionary must give notice to the Town Council of every alteration and addition which he intends to carry out in the conduc-

tive net. Three days previous to taking any work in hand, he must advise the municipality, except in urgent cases of damage, in which he may begin the work on the day when he gives notice. He must also prepare a list of the enquiries submitted to him concerning a supply of electric energy, and communicate it every month to the municipality.

Taxes, and Exemption from Taxation.

Section 13. During the entire duration of the concession, the municipality will not impose upon the production and the consumption of electric energy any new and special municipal tax either for lighting or the transmission of power. Up to January 31st, 1903, all fuel required for the boilers will be free from all taxation, but the committee of the council is entitled to ascertain the quantity of the materials really used.

Protection for Materials.

Section 14. For the protection of the materials arriving for use, the same measures will be taken as if they were the property of the town.

Meters.

Section 15. With the exception of cases where special agreements have been entered into, every consumer must be supplied on hire with a meter on the scale of prices to be established. Such meter is to remain the property of the concessionary.

All the costs of verifying, inspecting, and, if needful, repairing the meter, devolve upon the concessionary. The consumer must always allow his representatives access to this instrument.

The model meter which is to be adopted for use must be submitted for approval to the committee of the municipality, who, however, undertake no responsibility of any kind, either to the concessionary or to other persons in case of disputes which may arise from the use of the meter.

Section 16. Single installations of consumers.

As far as the meter, the installation must be executed at the exclusive cost and responsibility of the concessionary. From the meter it is open to every consumer to claim for his own installation the work of the concessionary, either purchasing from the latter the necessary material or obtaining it on hire. He may, however, use any material as he sees fit, and cause it to be executed by any person without the concessionary being entitled to prescribe special models or types of lamps, motors, &c.

The interference of the concessionary must be limited to ascertaining that the strength of current flowing through the meter in no case exceeds the energy required by the consumer, and to satisfying himself that in such private installations all the required measures for safety are adopted, so as to avoid any accident in regulating the rest of the service.

Scale of Prices.

Section 17. With the exception of special agreements, the price of the current for whatever purpose it serves will be calculated by hours and per 1,000 watts read off on the meters. Consequently, in agreement with the committee of the municipality, a general tariff will be determined on containing a fixed annual tax which is to be paid by each consumer in proportion to the maximum quantity of current which he states in his application to the concessionary that he will require, and a charge for every 1,000 watts actually used and indicated on the meters. This consumption charge will be fixed on the basis of a tariff increasing inversely, the current supplied being charged lower in proportion as the consumption increases.

Increase of the Tariff.

Section 18. The tariff, fixed in agreement with the municipal committee, is to be considered as a maximum not to be exceeded in the supply to private persons. The concessionary, however, is free, even in the agreements concluded with consumers, to go below the stipulated limit.

A rise of the tariff is permissible only up to the limit of any State taxation which may be ultimately imposed upon the electric transmission of power or of electric light.

Reduction of the Tariff.

Section 19. The concessionary must keep prepared an account of the total electric energy supplied ready to be submitted to the municipality. As soon as the total energy exceeds a total quantity still to be determined, the town will be at liberty to claim from the concessionary, at the end of each biennial period, a reduction of the tariff on the basis of the greater consumption of energy as registered in the last two years.

The Use of Electrical Energy for the Purposes of the Town.

Section 20. The municipality does not pledge itself to the concessionary that it will employ the current for lighting the public places or official buildings. If the municipality should wish to do this it has the right to a discount of . . . per cent. as compared with the scale paid by private consumers.

Obligation to Supply Current.

Section 21. The concessionary cannot withdraw himself from the obligation of supplying current within a certain time to every person who requests it, unless the distance from the consumers to a lead which is in action is too excessive, or the quantity of available energy does not allow of their demand being granted. Especial regulation will be drawn up in accord with the Town Council.

Precautions and Inspection during the Service.

Section 22. The concessionary must at his own expense take steps for carrying out all electrical and photometric tests and precautions which the town may consider requisite in the interest of the safety of the installation during working, or for securing the obligations of the concessionary towards private persons in return for their payments. The representatives of the municipality will at all times have free access to the station and other localities which are devoted to the electric service.

Redemption on Behalf of the Town.

Section 23. On the expiry of the concession the town reserves to itself the right to buy up the entire material—station, buildings, machines, leads, &c.—at a price to be fixed on the basis of the present value of the materials, independently of their industrial valuation. In disputes, recourse will be had to the commission mentioned in section 28.

Lapse of the Concession.

Section 24. The concessionary forfeits all the rights of the concession:—

(*a*) If he transfers entirely or in part the concession which he has obtained to any other person without the sanction of the town council.

(*b*) If he does not take the work in hand within six months from the day of concluding the agreement.

(*c*) If within 18 months from the same day he is not in a position to supply a minimum quantity of energy to be agreed upon.

(*d*) If during the continuance of the concession he entirely interrupts the supply of electric current more than twice within 30 days without previous permission of the committee; this stipulation does not refer to cases of *vis major* not due to imperfect working.

(*e*) If he does not meet the duties prescribed below in section 26.

(*f*) If he does not within six months meet all demands for the supply of energy according to the stipulations of section 21.

Legal Domicile.

Section 25. At the signature of the agreement, the concessionary must have selected a residence in Pisa, and engaged a representation in legal form. An alien company must be in possession of a permit to exercise their industry in the kingdom.

Definite Security.

Section 26. Within one month from the date of the agreement the concessionary must pay into the municipal treasury a definite security of 50,000 lire in bonds of the public funds, the interest of which he will enjoy after expiry. When the formal revision of the installation has taken place, and the service has commenced, he may substitute for this deposit-a mortgage upon the existing plant which the committee of council may consider sufficient for the fulfilment of the agreement.

Penalties on the Lapse of the Concession and Fines during Service.

Section 27. If the concession lapses according to section 24, after the conclusion of the agreement, but before the commencement of the works, the sum deposited as final security is forfeited to the municipality.

If the lapse takes place during the execution of the work, all portions which have been carried out, and all the materials brought into use likewise pass into the possession of the town, which will be entitled either to complete the installation, or to hand them over to third parties. If, further, the lapse takes place after the completion of the works and the commencement of the service, the town will carry on the supply for a time at the cost of the ex-concessionary, and institute an auction for the sale of the plant, machinery, and the entire existing installation at a reserved price. If no sale is effected, another auction will take place, the reserved price being reduced by 10 per cent. In any case the security, or a portion of the capital equal in value secured by mortgage, will pass into the possession of the town as a forfeit.

If during the service it is found at the visits of inspection of the representatives of the town, or in any other manner (section 22), that a violation of the stipulations of the concession is being carried on by the concessionary, (*a*) according as this breach involves a smaller or greater injury to the public, a fine will be imposed varying from 50 to 500 lire.

(*b*) In case the breach diminishes the safety of the installation in opposition to the prescribed regulations, a penalty will be imposed of 100 to 1,000 lire.

(*c*) If there occurs a partial cessation of the service for more than 15 minutes in the distribution of the current, there will be imposed a penalty of 5 to 1,000 lire, according to the quantity of current the supply of which is suspended.

(*d*) If the interruption is general and lasts for more than 15 minutes, the penalty incurred will be 1,000 lire, and if the interruption is repeated within the time of 30 days, the penalty of 2,000 lire will be imposed.

In the cases *a*, *b*, *c*, the concessionary must at once give notice to the town, and forthwith see to the removal of the defects which gave occasion for the imposition of the penalty. For every day's delay over and above the stipulated time the penalty may be repeated. The town has also the right to take the required precautions at the cost and risk of the concessionary.

Arbitrators.

Section 28. All questions which may arise concerning the interpretation of the present concession will be referred to a board of three arbitrators, one of whom will be selected by the town council, a second by the concessionary, and the third by the two parties jointly. If this is not possible, the appointment of the third will be left to the president of the law court of Pisa.

Costs of the Agreement.

Section 29. All the expenses of the present concession devolve upon the concessionary.

ON THE TELEPHONING OF GREAT CITIES.

ON a first perusal of the paper by Mr. A. R. Bennett, read before the British Association and published in our last issue, it is somewhat difficult to decide whether it is intended to be a production of the "Looking forward" character, or whether it is a serious attempt to solve the problem propounded. Since the meeting of the Association, doubts on the subject are set at rest, as the Duke of Marlborough, in a letter to the *Times*, states that it is the intention of the New Telephone Company to proceed with the construction of exchanges and provide telephonic communication in accordance with the plans proposed in the paper. Mr. Bennett says that the question of supplying the demand for telephonic exchange connection which is bound to arise after the lapse of a few years is a matter which has never yet been seriously faced. We are sure that the problem is one which must have engaged the attention of every telephone engineer who has a large exchange under his charge, and who finds it from his daily experience one requiring serious consideration, and not too confident assertion of the success of any solution which he may propound without the confirmation of experience. When, therefore, we find a paper like Mr. Bennett's which settles the question once for all, and leaves no doubt in the mind of its author or in that of the Duke of Marlborough that its success is complete, we think it behoves us to submit the plan to some criticism which may help to determine whether it is one of those which can be said to have been carefully thought out, and whether the conclusions reached savour of exaggeration, or are justified by the evidence which the paper contains.

Mr. Bennett's plan is composed of two main features :—

1. Exchanges for each square mile area to which the subscribers' lines would be brought ; junction wires from those district exchanges to one or more central exchanges through which communication would be obtained between subscribers in different districts.

2. The adoption of the "Mann" system of exchange communication.

Whilst Mr. Bennett combines these two features they are not at all dependent the one on the other. A number of exchanges in one city may be worked on other than the "Mann" system, and the "Mann" system may be worked without numerous exchanges. It may therefore be advantageous to first consider their suitability for the purpose in view, each for itself, and then to consider their suitability combined.

The principle of numerous exchanges is not new. As will be seen from the report of the discussion at the British Association, which we publish to-day, Major-General Webber reminded Mr. Bennett that he had proposed a similar plan in 1880, when the City of London was laid out for 200 exchanges ; and the existence of numerous exchanges has been the rule in almost all towns where the telephone was introduced in its early days. We believe that the number of exchanges in a town has been almost invariably reduced, whilst the number of subscribers has equally invariably increased. That is to say that the expansion of subscribers has led to a concentration of exchanges. This is a movement so general as to be almost entitled to acceptance as the right one without enquiry ; but since Mr. Bennett reverts to the older system, it is worth while to give a moment's consideration to the principle underlying this general concentration.

The larger the number of hands through which a call passes, the greater is the time occupied, the risk of error, and the cost as represented by operating expenses. The larger the number of subscribers in one exchange, the smaller is the proportion of connections to be made outside it, with a consequent minimum in time, risk of error, and cost of operating. This assumes that all subscribers in the exchange can be obtained by each operator. Telephonically there is little difference between separate switch-rooms and separate switchboards. Both have given way to the requirements of the principle that a call must, as far as possible, pass through the hands of one operator only.

The "Mann" system of exchange communication is one by which the subscribers notify their call to the operator by word of mouth instead of by visual signal. This system is better known as the "Law system." Whilst it has been spoken of as new it is in reality the oldest.

In the comparisons made by Mr. Bennett, the signalling system is described as the "American" system, and the circuit wire system as the "Mann system." The selection of such definitions naturally tends to the assumption that the "Mann" system is not an American system, and this definition is doubtless responsible for the unfortunate patriotic remarks of Prof. Silvanus Thompson—remarks which cannot fail to excite ridicule when they are so sadly misplaced. The signal system may be called universal ; the circuit-wire system is characteristically American. It is an adaptation to telephones of the American district telegraph system, in which a number of instruments are connected with a central office, as it were in series on one wire. For district telegraph use the circuit wire was the only means of communication ; applied to telephones the circuit wire was for service use only, lines direct with the central office being used for subscribers' conversations. The difference between the Law circuit wire, as originally used, and that known as the Mann circuit wire is that whilst the first was a continuous line the second is a main line with branches, the branches only being led into subscribers' offices, so that a derangement of the main line becomes less likely to occur, and a fault in one subscriber's office does not break the communication with all the other subscribers on the same circuit.

A comparison of the two circuit wires will be found in "The Telephone" (Preece), pp. 306, 307, and on p. 304 it is stated, "the ordinary working is as in the Law system." The Mann system, then, is not a system of telephonic communication, but merely a modification in the method of running a service wire. As such it is meritorious, and overcomes a previously existing danger of derangement. But, supposing that in the new telephonic scheme the further modification of the service wire, based on Mr. Bennett's discovery for the utilisation of telephonic induction, be adopted, it becomes incorrect to speak of the Mann system at all, because the service wire has no branches.

It sometimes happens that defects which may exist in two parts, when considered separately, are removed when the two parts are combined in one whole ; but we do not find this to be the case in the plans proposed by Mr. Bennett. There is nothing in the circuit wire system which enables the number of hands through which a call passes to be reduced, and, as proposed by Mr. Bennett, there is much in it which increases the liability to error, the loss of time, and the monopoly of junction wires which the operator is totally unable to prevent. The service wire system of communication between exchanges is valuable, and, we believe, general, but with the limitations proposed by Mr. Bennett, a great part of its value is lost, and some serious difficulties interposed.

The reasons given for the adoption of the two plans abovementioned are :—

For the square mile area exchanges—

1. The large increase in the number of subscribers which may be expected in the future, and the necessity of providing for them in the present.

2. The shortness of the lines ; the consequent economical construction of those lines ; the simplicity and cheapness of the switching apparatus ; the whole enabling the annual payments of subscribers to be kept down to a minimum.

For the circuit wire system—

1. The certainty and celerity with which connections may be made.

2. The ease with which one connection may be broken and another obtained.

3. A further simplification of switching apparatus.

4. Connections through many switch-rooms without the intervention of intermediate electro-magnets.

5. Other conspicuous merits not enlarged upon.

The necessity of forethought in planning any enterprise is undoubted. Except for Mr. Bennett's paper, we should have thought that in telephonic enterprise especially, it would be impossible to exercise too much. We are, however, constrained to think that the line on which Mr. Bennett proceeds is based somewhat too much on the assumption that we know to-day all that we shall know to-morrow, and that our descendants will be no wiser, telephonically, than Mr. Bennett is now. There are some conditions, some requirements, which we do not know for certain, but which we have every

reason to believe, will continue to exist. These should be provided for with ample margin. There are some other conditions which experience shows are likely to undergo some change, and may be considered to be capable of improvement. A paper of the scope of Mr. Bennett's should leave out of account neither of these considerations.

On April 26th, 1883, Major-General (then Lieut.-Col.) Webber, lecturing before the Society of Arts, propounded a scheme of exchanges for the future with almost as much confidence as does Mr. Bennett now. Major-General Webber then said: "The area of an exchange system will probably depend on the number of subscribers living within that area; after the number exceeds 500 the area should be diminished, as an exchange then begins to become unmanageable." When it is remembered that exchanges of 5,000 and 6,000 subscribers are now managed with ease, it will be seen that a plan contemplating such hard and fast rules would have been a mistake then, and, inferentially, would be a mistake now. Undoubtedly a plan should be comprehensive, but it need not be based on speculation in regard to the number of subscribers to be obtained, and the assumption that the future has nothing in store to assist in meeting their wants.

The shortness of the lines and economy of construction is a consideration which has a *primâ facie* case to recommend it, but the question of economy has to be considered, not in one feature, but in all. So far as we have been able to learn, telephone engineers, by experience gained on a somewhat larger scale than at Galashiels, have been enlarging the area of their exchanges, and if they have thereby incurred a greater expense for lines, we think it may be assumed that they find economies in other respects which more than counterbalance it.

If other exchange managers all over the world are wrong, then Mr. Bennett may be right. But other exchange managers are working on experience gained, and it appears to us that Mr. Bennett's paper lacks the proofs necessary to convince them of being wrong.

In the adoption of the circuit-wire system, Mr. Bennett again places himself in antagonism to the majority of telephone managers. As we have remarked, it is not new. It is old. Numbers of exchanges have been fitted with it, and have abandoned it. A few remain. The majority may be wrong, just as the eleven jurymen are obstinate; but, again, we think that in a scheme such as Mr. Bennett's, a contradiction of established usage should be supported by good reasons.

We have tabulated above the reasons given for the adoption of the circuit wire system, and may now comment upon them:—

1. The certainty with which connections may be made does not appear to us to be greater than with the signal system. A fruitful source of uncertainty is in the giving of numbers by subscribers. The circuit system has two such uncertainties, the signal system one. Another source of error or uncertainty is in the number of subscribers to be attended to. In the signal system the number of subscribers on her line is under the operator's control, on the circuit system not. A number of subscribers may be clamouring for connections to the confusion of the operator and the consequent increase of liability to error. Mr. Bennett says that simultaneous calls do not occur beyond the power of the operators to attend to them. But it seems to us that this will largely depend upon the relative patience and forbearance of the subscribers which, in the rush of a great city, should not be too much depended upon. The celerity with which connections may be made Mr. Bennett supports by figures, which we shall have occasion to refer to later.

2. The ease with which one connection may be changed for another is a claim the value of which requires to be considered in connection with the monopoly of lines also referred to later.

3. The simplification of apparatus claimed is partly correct. That is to say, the signals and keys enabling the operator to conduct her work in the manner prescribed are not required in a system which does not use signals, or give the other facilities, but apparently in the opinion of the majority of telephone engineers such apparatus serves a useful purpose so well as to make their retention, and not their absence, economical. Whilst the central is in one respect simplified, it is set off by the circuit wires and additional apparatus at subscribers' offices.

4. Connections through many switch-rooms without the intervention of intermediate electro-magnets is common to both systems.

5. We presume that the same may be said for this claim too.

The celerity with which the circuit system is operated, in comparison with the signal system, is set out by Mr. Bennett in tabular order. It was a casual examination of this table which induced us to look more narrowly into the general details of the paper. The method adopted is so unscientific, that it is with some surprise that we find such figures placed before the British Association for the Advancement of Science. The number of movements is dealt with, no account whatever being taken of their value. Manual operations only are considered worthy of being noted, to the exclusion of brain work, and though these may be excused as being merely matters of judgment, we think that sufficient care should have been exercised in revision to prevent the counting as one operation on his own side of that which is given as two on the other. Operations 2 and 4 on the "American" system are included in 2 only on the "Mutual" system. Many of the operations are counted as one on both sides which should be counted as two, and since the comparison is a proportional one, it is of more importance than it may seem to be at first sight. We think that a more scientific method of estimating the values of the connecting and disconnecting operations would show that Mr. Bennett's proportional figures are altogether inaccurate.

For two exchanges Mr. Bennett doubles the operations. We doubt whether there are any signal exchanges at work in contiguous areas in which such a method is adopted as Mr. Bennett gives in his calculation. It is quite conceivable that for communication between exchanges in the same town, methods may be adopted which are not applicable to ordinary subscribers. A service wire is general for inter-exchange communication; various methods are in use. We believe that a quicker method than that given on Mr. Bennett's side is practicable; and, considering that the system advocated contemplates a majority of calls passing through at least two exchanges, whilst the signal system is adapted for large areas, with one exchange only, it would appear that the comparison which should be made is that of the circuit system with two exchanges against the signal system with one; but the value of any such comparison is slight. More importance may be attached to experience.

Having now considered in greater detail than we originally contemplated some of the features of the two systems raised by Mr. Bennett, we may take a more general view of the paper. It is quite certain that perfection cannot be obtained by any one system. By concentrating attention on one set of requirements to the exclusion of others, apparent advantages may be set forth. Only experience can determine whether they are worth what they cost. Let us take an example. Mr. Bennett says "privacy must be complete." To attain it the operator must be absolutely prevented from placing her telephone on any subscriber's line. Mr. Bennett, in the adoption of the "Mann" system, places this prevention in her way. In the adoption of the numerous exchanges system, he also provides that the majority of communications shall pass over junction lines, and if two subscribers desire to monopolise a junction line for an unreasonable time, or neglect to give the order to disconnect, the line is monopolised to the detriment of the general service, and any other subscribers who may wish to communicate with those so connected cannot obtain them. To obviate this, a time limit would be necessary, and possibly a disconnection in the middle of a conversation. We have seen it somewhere remarked that there is a general impression that telephone operators have nothing to do but listen to subscribers' conversation, just as it used to be supposed that a postman whiled away his time by reading postcards. If the provision of means for talking or listening on a line gives facilities for operating the exchange not to be obtained in other ways, the chance that an operator may have any time at disposal to listen to a conversation may reasonably be taken, and when it is claimed that privacy must be complete, it is surely curious that the means selected for providing it is the one which leaves it open to any subscriber on a circuit to hear the number asked for by any other subscriber on the same circuit. Yet this is exactly what happens on the circuit system which Mr. Bennett proposes to use. We do not regard it as a

serious defect if the system has other merits to counteract it, but it is quite conceivable that the opportunity might on some occasions be utilised to the detriment of a subscriber. Another consideration which arises is the extent to which the success of Mr. Bennett's circuit system depends on the due performance of their duties by the subscribers. Much can be done in this respect by educating them, but there will always be new subscribers and the fault of one may cause trouble to many. The signal system is provided with means for remedying the defects arising from subscribers' neglect. Mr. Bennett dispenses with those means and claims advantages of economy thereby. It seems to us that such economy may be, and apparently experience shows is, dearly purchased.

When Mr. Bennett gets beyond his great city and refers to continental connections he appears to overlook that instead of intercommunication with continental subscribers being a consequence of the adoption of his system, it would be difficult to have that communication unless similar plans of service were adopted in, say, Paris and Brussels too. Supposing that Paris, in common with others, have adopted the signal system, it would be necessary for Mr. Bennett to succeed in convincing them that the circuit system is the only one possible, and inducing them to make the change. In event of failure so to do the London system would be isolated. Brunel may have been right in thinking 4 feet 8½ inches too narrow a gauge to obtain the best results of railway working. He may have been more right than, we fear, Mr. Bennett is, but he did not succeed in inducing others to alter their systems, and his line suffered isolation in consequence until it was altered in accordance with the plans generally prevailing.

With the attention we have given to his paper we regret to say that we can place but little confidence in the conclusions at which Mr. Bennett arrives. The subject of the paper offered an excellent opportunity for a well-considered practical plan, temperately put forward, and practically sustained. The opportunity has been lost and we have had instead exaggerated views of a very one-sided character, and the over confident expression of individual opinion against the experience of able men in all parts of the world. Instead of a recognition of the difficulties which the problem presents and a reasonable modesty in attacking them, Mr. Bennett slurs them over as he does also the defects of his own system, whilst exaggerating the defects of others. Such is not the way in which the question of "Telephoning of Great Cities" is to be solved.

NOTES.

Telephony.—During the past week a number of letters have appeared in the *Times* on telephony, which will no doubt produce good results in one way or another. Any revival of interest must be advantageous, and full discussion will probably lead to well-informed conclusions. Mr. Bennett's paper, read at the British Association, led to the correspondence, and we have thought the matter of such importance as to examine that paper somewhat in detail, and to criticise it freely on the points in which it differs from well-established usage. The paper is one which lends itself to criticism, and we are sure the author will neither expect, nor desire, that it should pass uncriticised. We confess to a feeling of regret that, whilst providing much interesting material for thought, he should have, as it seems to us, lost a good opportunity for propounding a practical scheme; but if our criticisms should lead to modifications of the plan on his part, or to such extended examination by those embarking in the contemplated enterprise as will either convince them that their calculations are correct or lead to the amendment of their Constitution, we think that some good will be attained. The comparisons which we have made show too little regard, by the author of the paper, for the lessons of experience. Both in the paper and the discussion there seemed also an absence of knowledge on his part of later developments. The comparison of Galashiels and a great city telephonically reminds one too much of the other Scotch comparison of Peebles and Paris for gaiety—with a preference for Peebles. The telephoning of great cities is a fine problem, and it needs to be handled with a freedom from prejudice; a readiness to profit by experience; a knowledge of the latest tendencies towards improvements; and a comprehension of the requirements of the city concerned, which, perhaps, only long technical experience on the ground, or careful study, can give. So long as the inhabitants get the service they desire, and at the most moderate price at which it can be furnished, it matters not how or by whom it is supplied, and we shall be glad to see the rival claims freely discussed.

Electric Lighting of Aberdeen Palace Hotel.—The installation of the electric light throughout the Aberdeen Palace Hotel has now been completed, and is of the most perfect description. A 10½ H.P. electro-motor drives a fan for propelling cold air through all the meat larders in the kitchen. The passenger and goods lifts are lit by electricity, and a perfect system of electric bells has been fitted up throughout the hotel.

Electric Light at Tarn's.—Fifteen arc lamps have just been erected, of 2,000 C.P. each, at Messrs. Tarn's, Elephant and Castle, for the illumination of the exterior of their large establishment in Newington Causeway and New Kent Road. The work has been carried out by Messrs. Rashleigh, Phipps and Dawson, of Berner's Street, W. Each lamp is provided with a separate connecting box in the pavement. Current for the lamps is obtained from the mains of the London Electric Supply Company.

Glasgow University and Prof. Helmholtz.—An address of congratulation, signed by the Principal and Professors of Glasgow University, has just been forwarded to Prof. von Helmholtz, of Berlin University, the eminent German physicist and physiologist, on the occasion of his completing on the 31st ultimo the seventieth year of his age.

The Frankfort Exhibition. — Forty-seven English people (including six ladies) and eight Americans (with one lady) are attending the International Electric Congress in Frankfort-on-the-Main. Prof. Silvanus Thompson won great applause for a lecture he delivered on Tuesday, in German, on "The New Sphere of Alternating Currents."

New Catalogues.—We have received a copy of an illustrated pamphlet just published by the Brush Electrical Engineering Company, Limited. It is descriptive of the Mordey Victoria system of alternate current distribution as adapted for central station lighting, and deals fully with switching and switchboards, street lighting by incandescent lamps, also the utilisation of water-power. The catalogue will, we think, be very serviceable to the electrical trades generally.

An excellently arranged and tastefully printed catalogue has just been issued by the Electrical Power Storage Company, in which full particulars and prices are given of the different types of accumulators and accessories now made by the company. Special attention is invited to the fact that the company is now prepared to consider proposals for the maintenance of storage batteries; that is, for the supply and fitting of new material in exchange for old, as and when necessary. An installation having been inspected, a rate is quoted which, according to circumstances, may vary in the case of lighting batteries from 10 per cent. to 20 per cent. per annum.

Messrs. Blakey and Emmott have sent us a nicely compiled catalogue of all things essential to electric light and power. The illustrations comprise "Blakey Emmott" continuous and alternating current dynamos, transformers, special engine and dynamo combination, differential arc lamp, switches, fuses, ceiling roses, lampholders, current meters and sundry fittings. Their price lists seem very complete, and advice and information are given on central station work, dynamo and arc lamp management, and estimates are published of complete lighting installations. Other valuable tabulated data on wires and cables, belting, accumulators, &c., is given, and altogether the book contains much of interest to the electrical trades

An Electrical Exhibition in Dorset.—It is reported that an electrical exhibition is to be held at Sherborne, in Dorset.

Bermuda Telegraph Service Demoralised.—It is stated that a terrible storm visited the Bermuda group the other day causing great damage to property, and the telegraph service was completely demoralised.

Newcastle.—Messrs. Barnett, Wynn and Barnard, electrical engineers, of Newcastle-on-Tyne, have secured a site for the erection of new works at Water Gate. The works are intended for the manufacture of electric lighting plant.

The New Post Office in Paris.—The contract for the electric lighting of the new post office in Paris has been awarded to M. Pieper, of Liège, Belgium. This is a remarkable fact, and especially so considering that the tender was the highest sent in.

The Chicago Exhibition.—A noteworthy feature of this exhibition is that no side shows are to be permitted within the grounds. The authorities have very wisely decided that the payment for admission shall entitle the visitor to see everything within the enclosure.

Paris Telephone Line.—The article by Mr. Addenbrooke, which we publish elsewhere, contains much suggestive matter, but the writer's argument with reference to the effect of the resistance of the receiving instrument and the resistance of the induction coil on the "K R" of the line does not appear entirely satisfactory; it seems to be assumed that the receiver and coil add both ohmic and self-induction resistance to the "R." Now, it is well known that a resistance coil wound singly, an induction coil, in fact, without the iron core, even of very high resistance, has very little effect in cutting down the speaking, because of the mutual induction between the turns of wire; it is only when the iron core comes to be inserted that a "plugging" effect is produced. The resistance, as resistance purely, has, in fact, but little effect.

History of the Electric Transmission of Power.—Dr. Silvanus P. Thompson, in his "Operatives' Lecture" delivered at Cardiff during the B.A. session, reiterates that "it was not until 1873 that two dynamos were actually joined together by wires and used, one as generator, the other as motor, to transmit power by wire electrically from one place to another." This experiment was made by M. Fontaine with two Gramme machines at the Vienna Exhibition. In view of the disclosures made by Mr. A. M. Tanner, in our issues of June 19th and 26th of the present year, it would seem doubtful whether MM. Gramme and Fontaine are entitled to the honour of a discovery, for Major Bessolo, of Corea, Italy, distinctly described a method of transmitting power electrically from a dynamo to an electric motor by means of wires, in a patent, dated January 19th, 1855. Dr. Wellington Adams, again, in a lecture delivered before the Engineers' Club of St Louis, U.S.A., in April, 1884, states that the principle of transmitting electric energy through wires to an electric motor on a railway car, had been proposed and patented as far back as 1840 by Henry Pinkus. The dynamo was then unknown, and the electric car motor existed only in the imagination of the patentee. Pinkus even went so far as to anticipate the future use of "mechanical generators which should be more economical" than stationary batteries, as originally proposed. If M. Fontaine, who was well acquainted with electrical matters in general, has been aware of the suggestions thrown out by Pinkus or by Bessolo, then he can only be credited with carrying into effect the inventions of others as soon as the means to do the thing were available. Dr. Thompson, who has been eminently successful in unearthing the discoveries of Reis, Sturgeon, and others, would confer an equally important act of justice in following up the early work and reasoning of the discoverers of the principle of the electric transmission of power by means of dynamos and motors.

Electric Road at Kankanee.—This town, which is about 56 miles south of Chicago, now possesses an electric railway system which, it is said, is probably unexcelled by that of any other town of similar size in the same country.

The Edison Phonograph Syndicate.—Arrangements are now being privately made which, it is said, will place Edison's phonograph on a commercial footing. A syndicate is being formed to obtain the control of the business in the United Kingdom. The capital is fixed at £75,000, which will purchase 1,000 phonographs in complete working order delivered in London. We have heard this kind of thing before.

The Electric Lighting of Churches. — Numerous churches in and around London are now illuminated by means of electricity. The latest addition is that of Christ Church, Lancaster Gate, in the chancel of which about 100 incandescent lamps have been fitted, current for which is obtained from the supply mains. The work has been carried out by Messrs. Rashleigh Phipps and Dawson, of Berners Street.

Oxford Electric Lighting Company.—It is stated that the prospectus of the Oxford Electric Lighting Company, recently registered, will not be issued to the public for some little time yet. It is said that the prospects of the undertaking in question seem particularly bright, and that the men behind the scheme are both technically and financially strong. Oxford should be a most eligible place for an electric lighting installation, and it seems that the colleges will support the company in a most subtantial manner.

The Lauffen-Frankfort Scheme.—On the 2nd inst. the Wurtemberg authorities conducted a series of experiments with the plant at Lauffen, to finally test the working of the safety appliances. The tests, which were exhaustive, were successful, and on their termination, the working of the transmission plant was definitely handed over to the two firms concerned. On the 3rd inst. the general director of the Wurtemberg Telegraph Administration sent a telegram to the Exhibition Committee, expressing full satisfaction with the previous day's tests, and expressing the hope that the success of the installation would act as an incentive to further progress in the electrical transmission of power in Germany.

The Institution of Electrical Engineers.—A special general meeting of members only was held at the offices of this institution on Monday last, when resolutions embodying the following alterations were submitted:—Members elected after December 31st, 1891, will be charged an entrance fee of £3. Foreign members' entrance fee, one guinea. Every associate elected after the said date, £1 10s. Associates transferred after December 31st, 1891, will be charged a further entrance fee of £1 10s. Students transferred to the class of associates—entrance fee, one guinea. Members elected after December 31st, 1891, annual contribution, £3. Associates, £1 10s. Foreign members, £1, and every student half a guinea. Members or associates residing abroad for nine months in any year, £1 annually. Members elected after the above date may compound by the payment of £25 if resident in the United Kingdom, or £10 if resident abroad. Associates, £12 10s. if resident in the United Kingdom, or £10 if resident abroad. Foreign members, £10. Foreign members coming to reside in the United Kingdom, if elected after the said date, £15 additional composition or £2 annual subscription. Associates residing abroad and coming to reside in the United Kingdom, elected after the said date, shall pay an additional composition of £2 10s., or 10s. annually. Foreign members who have not compounded, coming to reside in the United Kingdom, annual subscription £3, if elected after December 31st, 1891. Associates resident in the United Kingdom, who have compounded by payment of £10, if transferred to the class of members after the said date, additional composition £15, or £2 annual subscription. Associates resident in the United Kingdom elected after the said date, annual subscription £3.

Electric Lighting in France.—The inauguration of the electric light in the town of Nomény-Meurthe et Moselle will take place on the 13th inst. The power for driving the plant is obtained by means of a turbine, from the Seille.

Fatal Accident at a Paris Theatre. — A terrible accident occurred at the Châtelet Theatre last Sunday night. A workman, while greasing the machinery for the production of the electric light, fell between two cranks and was instantly torn to pieces. Death was so sudden that he had not time to utter a cry.

Telephones in Madrid.—An interesting article on this subject appears in the last number of *L'Electricien*. The first telephone service was opened in 1883. At the present time there are 644 subscribers to the telephone service. The annual charge for use of the telephone was originally £24 per annum, but it was reduced some years ago to £12.

The Berlin-Munich Telegraph Cable.—The underground telegraph cable between Berlin and Munich was inaugurated on the 21st ult. It contains seven conductors, and is 460 miles long. The total cost, borne partly by the Imperial and Telegraph Administration and partly by the Bavarian Telegraph Administration, has been £225,000.

Proposal to Construct Electric Railways in Berlin.—Messrs. Siemens and Halske have submitted a proposal to the Prussian Minister of the Interior and the Berlin Municipality for the construction of elevated electrical railways throughout Berlin and the suburbs. They propose to construct eight different lines, covering some 40 miles, at an estimated cost of 80,000,000 marks.

Electric Railways of 1891.—There are now in operation and under contract in America, Great Britain, Germany, Italy, Australia, and Japan no fewer than 325 electric railroads, requiring over 4,000 cars and 7,000 motors, with 2,000 miles of track, making a daily mileage of not less than 400,000 miles, and carrying 750,000,000 passengers. One-fourth of the street railways of the United States are being operated wholly or in part by electricity.

Dundee Electric Lighting.—At the monthly meeting of the Dundee Gas Commission, the electric lighting committee's report was submitted. It stated that the committee had visited Bradford, Deptford, and other places, and they recommended the adoption of the low-pressure continuous current system. They could not get reliable information as to cost, but that to the consumer it would be considerably over that of gas might be reasonably expected. The Commissioners finally agreed to hold a special meeting this week to consider the subject.

Prof. Silvanus Thompson on the Americans.—On the discussion which took place on Mr. Preece's and Mr. Bennett's paper at the recent British Association meeting, *Engineering* comments as follows:—"Prof. Silvanus Thompson made some remarks, which we notice, in order to protest against them as being uncalled for. No doubt there are certain citizens of the United States guilty of bad taste in decrying everything done abroad, and claiming for their own country the merit of originating all important advances. But these people are a minority, and even if it were not so, their existence would not warrant Prof. Thompson in saying, in regard to electrical matters, that Americans think they lead the world. When he adds that we, 'our noble selves,' lead the world, he identifies himself with that, happily small number of Englishmen who are given to what we call 'bragging,' and Americans call 'spread-eagleism;' but which is objectionable to the majority of electrical engineers on both sides of the Atlantic. Americans are, as a body, ever ready to acknowledge the debt they owe to European, more especially English, physicists and engineers, whilst we trust that Englishmen are equally willing to admit that Americans show energy and resource in turning the discoveries of science to actual use, and this is the reason they often outstrip us in practical showing." No one can read Prof. Thompson's remarks without coming to the same conclusion as *Engineering*, for they were conspicuous for their want of good taste.

Portsmouth Electric Lighting.—Referring to our note of last week on this subject, we now learn that the Portsmouth Town Council decided on Tuesday last to adopt the electric light, and agreed to borrow £60,000 to cover the cost of the site and machinery.

Goldsmith's Institute, New Cross.—Large numbers of students are entering for the technical classes, which open early next month. The Electrical Section appears to be the favourite, 128 students having already presented themselves; 88 of these desire to take up the heavy electrical engineering courses, *i.e.*, lighting and transmission of power.

Postal Cables. — Preparations are being made at the London Central Telegraph Office for the early transfer of the postal cables to the continent from their present abode at Throgmorton Avenue, which formerly belonged to the Submarine Telegraph Company, to the former building. The removal, when completed, will be the means of bringing many large continental towns into immediate communication with those in the provinces.

Appointment. — The Glasgow Corporation Electric Lighting Committee had personal interviews last Thursday with the six selected candidates for the post of electrical engineer to the Corporation. After carefully considering the merits, qualification and experience of each of the six applicants, the committee unanimously resolved to recommend that Mr. William Arnot, at present electrical inspector for the London County Council, be appointed as electrical engineer to the Glasgow Corporation at a salary commencing at £250 per annum, the engineer to devote his whole time and attention to the duties of the office, and the appointment to be during the pleasure of the corporation.

The Electro-Technical Congress.—A telegram from Frankfort states that the International Electro-Technical Congress was opened there on the 8th inst. with an able address from Dr. Stephan, Imperial Minister of Posts and Telegraphs. Some 650 members, of whom 198 were foreigners, attended the proceedings. After the usual complementary speeches the following gentlemen were elected presidents of the various sections of the Congress:—Dr. Siemens, of Berlin; Mr. Preece, of London; M. Hospitalier, of Paris; Signor Ferraris, of Turin; Herr Waltenhofen, of Vienna; and Prof. Kohlrausch, of Hanover. It was decided to create a special section to consider the principles of legislation dealing with electro-technical matters. Several papers were subsequently read.

Electric Lighting at Eastbourne — Reduction in Price.—At the monthly meeting of the Eastbourne Town Council on Tuesday last, the Lighting and General Purposes Committee reported that the borough surveyor had submitted a letter from the manager of the Eastbourne Electric Light Company, Limited, stating that the charge in the proposed new contracts would be 10d. instead of 1s. per unit, representing a reduction of nearly 17 per cent. in the price. It was resolved that the borough surveyor be authorised to sign the contracts on behalf of the Corporation. The council also adopted the following report of the borough surveyor, in which he said:—"I have been in communication with the Electric Light Company, and they do not recommend incandescent lamps for street lighting, and the cost would be quite prohibitive. The Electric Company are willing to supply and light arc lamps at 100* C.P. for £32 per lamp per annum. I have taken as a basis 32 lamps in the streets in which the company's mains are now laid, and I find that those 32 lamps would displace 16 Sugg lamps and 80 small. The comparative cost would therefore be—32 arc lamps at £32, £1,024; 16 Sugg lamps, £197 15s., and 80 small lamps £294 10s., £492 5s.—C. TOMES, Borough Surveyor." It was resolved that in view of the reductions offered by the Gas Company, the committee are not prepared to recommend the council to make any change in the lighting of the public lamps.

* The Sugg lamps are of 100 C.P., so this should evidently read 1,000, as we do not know of any arc lamp in use giving so small a light as that stated. Although electricity in this instance costs double the price of gas, the amount of light given would be more than 10 times as much.—EDS. ELEC. REV.

Electric Lighting in Leeds.—Recently the Leeds County Council determined to let the electric lighting of the borough to the Yorkshire House-to-House Electricity Company, Limited, and many enquiries are being made as to whether any progress has yet been made in the matter. Up to the present no move has been made by the company. This is due to the fact that so many Leeds people are away on their holidays, that it would be impossible at this time to form a local company, which it is intended to do. At the end of this month, however, steps are likely to be taken to float a company, if possible, composed entirely of Leeds gentlemen; but if this is not practicable, people in other parts of England will be allowed to take shares. When this local company has been constituted, it is said that it will set about its work immediately.

Electric Lighting in Southwark.—At the Vestry of St. George-the-Martyr, Southwark, on Tuesday, a letter was read from the London Electric Supply Corporation, Limited, asking the Vestry if it desired to adopt the electric light at the Vestry Hall. The prices quoted are:—When current used averages 33 units per 8 candle-power lamp per annum, equivalent to a daily use of 2¾ hours throughout the year, 7¼d. per unit; exceeding 33 and not exceeding 44, 7d. per unit; exceeding 44 and not exceeding 55, 6¾d.; exceeding 55 and not exceeding 66, 6½d.; over 66, 6¼d. The company will not supply wiring and fittings. For the purpose of storing their transformer the company will require a small iron fireproof compartment somewhere in the basement of the building. A number of members of the Vestry remarked that it was very desirable that the electric light should be adopted at the Vestry Hall, and the letter was referred to the General Purposes Committee for report.

Telephony in Demerara.—The British Guiana Postmaster-General's Report for 1890, just issued, has the following observations upon the Telephone Exchange:—"The new Telephone Exchange was opened on August 1st, 1890. The cost of construction was $13,119.80, defrayed by a loan from general revenue. The revenue collected from rentals amounted to $3,700. The exchange has worked with such satisfaction to the public that its extension has been eagerly desired, and was provided for in the supplies voted for the present year. The employment of lady attendants has proved so successful that complaints against the staff of incivility and want of attention are memories only of the past exchange. Provision has also been made for the establishment of an exchange of 50 renters in New Amsterdam, on a representation from the principal inhabitants of the town." There is also a generous acknowledgement of the services rendered in connection with the exchange, as follows:—"I have especially to express my sense of the energy and skill of Mr. Samuel Vyle, the electrician, which have been particularly displayed in the transformation of a much-abused telephone service into a most useful and popular branch of the Postal Department.

New System of Electric Railways.—In a new system of electric railways invented by Herr Heilmann, a steam engine and dynamo are carried in a vehicle which takes the place of the present locomotive. Current is conveyed by conductors, which pass under the carriages, to a series of electric motors, which drive some or all of the axles. A triple expansion engine is to be used, and in order to ensure equal work being done by all the motors, their armature coils are all in series with one another, and current is supplied from one dynamo. The field magnets of the motors and of the generating dynamo are excited by current from a dynamo working at a constant potential. The boiler is capable of developing 600 horse-power, and is of the type in general use on torpedo boats. The steam engine is coupled direct to the dynamo, which is a Rechniewski multipolar machine. A switchboard is placed in front of the vehicle, and openings are left through which the driver can look out. It is hoped that a speed of 50 miles on gradients of 1 in 200, and 75 to 80 miles on the level, will be reached. The motors, which are also of the Rechniewski type, are placed direct on the axles, and the cables are joined by couplings between the carriages. It is said that the directors of the French State Railways have placed rolling stock at the disposal of the inventor, and have given permission for experiments to be made upon their lines.

Electric Lighting at the People's Palace.—The cost of the installation of electric light at the People's Palace, Mile End, is being defrayed by the Draper's Company. The contract price is no less than £6,000.

Electrical Exhibition at Glasgow.—It is said that the latest venture in the exhibition line is the proposed Greater Glasgow Electrical Engineering Exhibition. The matter has been under discussion for some time, and a prospectus of the proposed show has just been issued. The object of the exhibition is to illustrate the best appliances suitable for the utilisation of electricity in Glasgow. The site is that of the late successful East End Exhibition.

Proposed Electric Traction for the Glasgow Tramways.—At a meeting of the Tramways Committee on the 27th ult. there was considerable discussion regarding the adoption of electricity, cable, or compressed air, as the motive power, instead of horse traction, on the Glasgow tramways. The sub-committee were instructed to get all the information they could regarding the matter, and it was agreed that the committee have extended powers granted them to make investigations as to the motor to be used for working the tramways.

Lithanode.—Lithanode may be regarded as the "active material" of the "peroxide plate" of a lead secondary battery, this active material being isolated from the heavy lead support and obtained in the form of a conducting plate. By the use of lithanode, a "peroxide plate" which is not subject to "local action" may be constructed; an inoxidisable metal, such as platinum or gold, being in this case used for establishing contact with the plate. A great advantage is thus secured; that of an element which will retain its charge for any length of time, even when partly discharged and left immersed in dilute sulphuric acid. The rate of discharge obtainable with lithanode batteries varies within wide limits, according to the character of the lithanode, the perfection of the contact, the strength of the acid electrolyte, &c. The Mining and General Electric Lamp Company, Limited, is now prepared to supply the electrical trade and the general public with lithanode plates for use as elements in both primary and secondary batteries. These plates may be obtained either alone or fitted with the company's improved contacts and terminals. The company strongly recommend the employment of their improved spongy-lead electrodes, which, in combination with lithanode, will be found to give the best known results as a means of storing electrical energy. The E.M.F. developed by lithanode, in conjunction with spongy lead, is 2·0 volts. With a combination of lithanode and zinc an E.M.F. of 2·5 volts is obtained. The electrolyte used is a solution of sulphuric and water, density about 1,220. The elements in the cells should always be kept well covered by the solution, and to compensate for evaporation pure water only should be added. The company's safety electric hand lamps have been especially constructed for use in such places as coal mines, where an absolutely safe illuminant is essential. In designing them, every precaution has been taken to insure perfect reliability. Each contains a small two-cell battery of the lithanode type, mounted in an outer steel protecting case. The company's miners' lamps have now withstood the test of time, and from the very satisfactory manner in which they have passed through some most severe practical trials in large collieries both in this country and abroad, they may be relied upon to fulfil all the requirements of a nearly perfect electric safety hand lamp. The company is also prepared to supply lithanode batteries suitable for lighting railway carriages, tramcars, omnibuses, broughams, and other vehicles. The batteries, as made for these purposes, are mounted in strong wood cases, and are fitted with special terminals and strong handles, and designed to withstand jolting and rough treatment. Full particulars and prices of any of the above lamps and batteries may be obtained on application.

An Electric Garden Engine.—As many of our country seats are now supplied with electric lighting machinery, Messrs. Merryweather and Sons have devised a novelty in small pumps, worked by the electric current. Messrs. Merryweather's pump is well suited for garden work, as it is only necessary to fix it by a pond or fountain and attach a suction and delivery pipe, when the little engine will project the water in the usual manner.

Running in Parallel.—Mr. Charles Ffrench, the European editor of our New York namesake, was joined in wedlock to Miss Florence Burt on the 9th inst. Brighton was the scene of the desperate deed.

Electric Light at Arbroath.—We omitted to state in our note of last week, under this heading, that the electric light installation in Mr. Lowson's Works at Arbroath, was fitted up by Messrs. Lowdon Bros., of 21, North Tay Street, Dundee.

Electric Motors.—A correspondent writes :—I should be also much obliged if you would ask in your paper the name of the people who are making small motors without commutators, as they exhibited in the Edinburgh Exhibition of last year.

Battery Jars.—Sowerby's Ellison Glass Works, Limited, are now manufacturing battery jars made from a new product, to which has been given the name of "natural glass." The strength and finish of these jars are said to be very superior to those made from ordinary material.

Telephones.—The telephone which a foreign subscriber mentions as having seen illustrated in an American and English paper, has not been noticed by us for special reasons. Probably the time is not far distant when we may find it necessary to express ourselves somewhat forcibly.

The Electric Lighting of the New Offices of "Tit-Bits."—The new offices of *Tit-Bits* and the *Strand Magazine*, in Southampton Street, Strand, are being fitted throughout with the electric light. The work is being carried out by Messrs. F. Suter & Co., of Berners Street, W.

Messrs. Joel and Co.—The annual excursion of the *employés* of the firm of Messrs. Henry F. Joel & Co., 31, Wilson Street, Finsbury, took place on Saturday, 29th ult., when a very enjoyable day was spent at the "Holly and Laurel," Holmwood, Surrey. Mr. Joel took the chair at the dinner, the toasts of the "Firm," "*Employés*," and "The Electrical Trade," being heartily responded to.

Ship Lighting.—On 29th ult. Messrs. Sir W. G. Armstrong, Mitchell & Co. launched a large steel twin-screw steamer, named *Ruthenia*. Everything is of the most complete description, and the vessel, which is 435 feet long over all, is fitted throughout with electric light, and with special deck lights to enable the cargo to be loaded or discharged at night. She has also search light for the Suez Canal.

The Crystal Palace Electrical Exhibition, 1892.—The special committee appointed by the Electrical Section of the London Chamber of Commerce to co-operate with the directors of the Crystal Palace Company in promoting the success of the exhibition consists of the following gentlemen :—Mr. R. E. Crompton, M.Inst.C.E. (Chairman), Major S. Flood Page, and Mr. Emile Garcke (Vice-Chairmen); Mr. J. E. H. Gordon, B.A., M.Inst.C.E., Mr. G. Binswanger, and Mr. Alexander Siemens, M.Inst.C.E.

NEW COMPANIES REGISTERED.

Fibrite Syndicate, Limited.—Capital £15,000, divided into 12,500 £1 ordinary shares and 500 £5 founders' shares. Objects: To adopt an agreement dated July 22nd, 1891, made between J. R. Thame, of the one part, and J. W. Taylor (for this company), of the other part, for the acquisition of an invention of improvements in the manufacture of electrical insulating materials, and an invention of improvements in the manufacture of seamless tubes or conduits for electrical or other purposes, and to use and exercise the said inventions. Signatories (with 1 share each): E. F. Weldon, 16, St. Helens Place, E.C.; A. H. Miller, 8 and 10, Moorgate Street, E.C.; Otto Friederici Ancot, Muswell Hill, N.; E. D. Wookey, 40, Umfreville Road, Harringay; W. H. Ball, 4, Lillington Street, South Belgravia; J. R. Thame, Boxmoor, Herts; E. Woodley Smith, 28, Budge Row, E.C. The number of directors is not to be less than three nor more than seven, the first to be appointed by the subscribers. Qualification £100. Registered on the 7th inst. by Jacobs and Weldon, Solicitors, 16, St. Helens Place, E.C.

Alex. Wilson and Company, Limited.—Capital £20,000 in £1 shares. Objects: To carry into effect an agreement with A. Wilson; to carry on the business of mechanical, electrical, metallurgical and chemical engineers. Signatories (with one share each): J. F. Hoy, 145, Palmerston Buildings, E.C.; F. Belcher, 39, Coleman Street, E.C.; J. B. Chamberlain, 5, Rupert Road, Chiswick; J. Hands, 92, Wandsworth Road, S.W.; W. H. Rattenbury, 13, Wyndham Road, Upton Park; E. Beermann, 80, Ladbrook Grove, W.; P. W. Morrison, 189, South Lambeth Road, S.W. The number of directors is not to be less than two nor more than five. Qualification £100. Remuneration £300 divisible. Registered on the 4th inst. by Ashurst and Co., solicitors, 17, Throgmorton Avenue, E.C.

CITY NOTES.

Bath Electric Light Company, Limited.

The statutory meeting of this company was held at Bath last week, when the chairman (Lieut.-Col. Vaughan) presided.

The CHAIRMAN explained that originally there were only five directors, but the Board had been strengthened by three London electricians—one gentleman from the Brush Company, one from the Callender Company, and one from the firm of Messrs. Laing, Wharton and Down—all of whom were large shareholders. Of the 13,500 shares offered, 3,241 had been subscribed. The accounts had been overhauled by Mr. Butcher, and they knew exactly the position they were in. At present the machinery was running only a portion of the day and night, but they hoped that an increase of custom would cause it to be running continually.

Mr. TITLEY, the solicitor to the company, said they were bound to call a meeting within a certain time after the company's formation, in order to enable shareholders to make enquires. There was one important point, and that was that with the present plant they could supply three or four times the amount of electricity.

Gen. JERVOIS stated that the attention of the directors had been very much directed towards reducing the cost of installations, if possible to such an extent as to invite people to come forward and have the light brought into their houses. No doubt very great difficulty arose from the fact of certain unavoidable cost being incurred when introducing electric light into houses. It was the policy of the company to reduce that cost as much as possible. Perhaps their progress, if not very rapid, would be sure. They hoped to induce people outside the electric lighting area to have the light brought into their houses from motors, which could be set up in the garden or outside premises without any trouble.

The CHAIRMAN said they must have time. He thought the company had a good prospect.

Mr. TITLEY said the company had a contract with the municipality, and they hoped for the goodwill of the citizens.

The meeting closed with a vote of thanks to the chairman.

The Railway Electrical Contractors, Limited.—It is announced that a general meeting of the members of the Railway Electrical Contractors, Limited, will be held on 23rd of next month, for the purpose of laying before the company an account showing the manner in which the winding-up has been conducted, and the property of the company disposed of, and for other business regarding the liquidation of the company.

The Commercial Cable Company, Limited.—The Commercial Cable Company announces the payment on October 1st of the usual quarterly dividend, at the rate of 7 per cent. per annum.

Roper's Electrical Engineering Company.—Mr. Percy Rosling, of Henley's Telegraph Works, has joined the board of Roper's Electrical Engineering Company, Limited.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ended September 7th, amounted to £5,279.

The City and South London Railway Company. Traffic receipts for the week ended September 6th, amounted to £672.

The Great Northern Telegraph Company. Receipts in August, 1891, £23,600; 1st January to 31st August, 1891, £180,400; corresponding months 1890, £181,000; corresponding months 1889, £178,200.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 9th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company were £3,565.

The West Coast of America Telegraph Company, Limited. Traffic receipts for the month ending August 31st, 1891, were £3,050.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Sept. 3rd, 1891.)	Closing Quotation. (Sept. 10th.)	Business done during week ending (Sept. 10th, 1891.) Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	47 — 48	48 — 49	48⅜	47½
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	86 — 87	86½— 87½	87¼	86½
2,849,510*l*	Do. do. Deferred	Stock	12⅜— 13½	13½— 14⅜	14	13½
130,000	Brazilian Submarine Telegraph, Limited	10	11⅜— 12¼	11⅝— 12¼	12⅛	11⅝
53,200*l*	Do. do. 5 p. c. Bonds	100	99 —102	99 —102	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978*l*	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2½— 2⅝	2⅝— 2⅞	2⅞	2⅝
69,996*l*	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅝— 2⅛	1⅞— 2⅛	2	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	3 — 5	3 — 5	...	...
$7,716,000	Commercial Cable, Capital Stock	$100	107 —109	109 —111	110⅜	109¾
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	⅜— ½	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4½— 5½	4½— 5½	...	...
16,000	Cuba Telegraph, Limited	10	10 — 11	10 — 11	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3½— 4	...	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9½— 10½	...	...
60,710	Direct United States Cable, Limited, 1877	20	11 — 11½	10⅝— 11⅛	11⅛	11
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 14⅝	14⅜— 14½	14⅝	14 7/16
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15⅜	15 1/16
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	108	107¼
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110	109	107¾
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	14⅞— 15⅛	15 3/16	15
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 —107	104 —107	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	106	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	107¼	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	104	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	103	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	98 —101	99 —102	100¼	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3¼— 4½	4¼— 4⅝	4 7/16	4
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2⅞— 3⅛	3⅛— 3⅜	3 7/16	2 15/16
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3⅞— 4⅛	4⅛— 4⅜	4⅛	4⅛
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅝— 2¼	2⅝— 2⅞	2¾	2 5/16
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9⅞	9⅝— 9⅞	9⅞	9⅝
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15½	14⅞— 15½	15½	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19½	18½— 19	18¾	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 —107 xd	104 —107 xd	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	10 — 11	10 — 11	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	19 — 20	19½— 20½	20⅛	19⅝
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	41 — 43	41 — 43	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9½— 9⅝	9½— 9⅝	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	104 —107 xd	104 —107 xd	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9⅜— 10½	9⅜— 10½	10 1/16	9¼
447,234*l*	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅞	4⅜— 4⅞	4⅞	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½—13½	12½— 13½	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½— 13	12½— 13	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	105 —107	106 —108	107½	106½
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	3½— 4½	3½— 4½	...	...
220,000*l*	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
9,000*l*	Reuter's Limited	8	8 — 8½	8 — 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6⅜— 7½	7 — 7½	7½	6 15/16
7,900	Do. do. do. 7 per cent. pref.	2	4¼— 4⅝	4½— 5	4 11/16	...
3,381	Submarine Cables Trust	Cert.	117 —121	120 —125	122½	121½
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4⅝— 5	4 13/16	4½
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	42¼
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	2 — 3	2 — 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	95 — 98 xd	96 — 99 xd	97½	96½
30,000	West Coast of America Telegraph, Limited	10	3¼— 3⅝	3¼— 3⅝	3⅝	3½
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 — 102	97 —102	...	...
67,007*l*	Western and Brazilian Telegraph, Limited	15	10⅜— 11¼	10⅜— 11¼	...	...
30,364*l*	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	...	...
30,364*l*	Do. do. do. 5 p. c. Deferred	7½	4¼— 4⅝	4¼— 4⅜	4 11/16	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	102 —105	102 —105	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅜— 2	1⅜— 2	2	1⅞
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	9¾— 10½	10½	10⅛
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	8⅛— 9½	8 — 9	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	98 —102 xd	98 —102 xd	...	...
42,853	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅛—5⅜	5⅛— 5⅜	5⅜	5⅛

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7⅞.—City of London Electric Lighting (Pioneer), Shares of £50, fully paid, 60—62.—Ordinary of £10 each, £2 paid, 2.—Elmore's Austrian Copper Depositing, 15s., 25s., £2 share issued at 10s. prem., fully paid, 1—1¼.—Elmore's Priorities, 3½—4⅛.—House to House Company (£5 paid) 4½—5.—Liverpool Electric Supply, £3 paid, 2⅜—2⅝.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅜—1⅞.—Manchester, Edison and Swan Company, £9 (£1 paid) ⅜ — ⅝.—National Telephone Debentures, 2½ — 3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2½—2⅝.—£5 Preference, fully paid 3¾—4.—Debentures 90—95.—Wards Electric Car, £10 paid, ⅜—1.

BANK RATE OF DISCOUNT.—2½ per cent. (2nd July, 1891).

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, CARDIFF, 1891.

DISCUSSION ON Mr. PREECE'S AND Mr. BENNETT'S PAPERS.

The following discussion was taken jointly in Section G, on Mr. Preece's, on the London and Paris Telephone, published in the REVIEW for August 28th, and Mr. Bennett's papers on "Telephoning in Great Cities," published in our last issue:—

Major-General WEBBER said that in such a paper as they had heard from Mr. Preece they were at a disadvantage, because the author was naturally tied down by his official position, and did not give to himself or those with whom he was associated, they being public officers, all the credit that they deserved. No doubt many of those present had watched what had been called long-distance telephony as accounts came out in the public press from year to year. They had seen reports of experiments that had been made between Paris and Brussels, associated with names which he need not mention here; and perhaps they had wondered that during so long a period no great success in establishing long-distance telephony had been achieved at an earlier date. It was owing to Mr. Preece and to those connected officially with the telegraph departments of Great Britain and France, assisted by that great factor the public purse of both countries, that long-distance telephony had been made a success; and that chiefly for the reason that those gentlemen early saw that it was necessary to have a metallic return. Those who investigated the subject in previous years had in view the utilising of existing telegraph lines, all of which had earth returns, and all their efforts were in that direction. The credit of showing that a metallic return was necessary was due to their chief electricians, as was also the inducing of those who had charge of the public purse strings to incur the necessary expenditure to enable it to be done in the way in which Mr. Preece had described. The achievement which Mr. Preece had described was one of the most marvellous public works that had been undertaken of this kind in this country and in this century. As regarded Mr. Bennett's paper, he was sorry it had not been read *in extenso*, as it deserved to be. He also thought that a great many present had not been able to realise the value of what he had brought before them. He had described the Mann's system of telephone exchanges, or rather he would have done so if he had had the time. The whole question was one that was very much before the introducers of the telephone in this country in 1880. At that time the advantage of a metallic return was well known. But it was a serious question to those who had to find capital for the establishment of telephone exchanges in the towns of Europe to incur the cost of two wires to every subscriber. The cost of one wire was, say, £10 per mile; the doubling of that for a large system meant a very considerable outlay. He must admit that, being largely interested in that establishment, when he had to give his vote he gave it in favour of one wire and earth returns. The effect of induction and other difficulties had since brought about the conclusion that the double wire was the best. He thought this was the natural result of experience, and he was glad to see that people were going to use this system. But they must also recollect that the Mann system necessitated a third wire—not a third wire to every subscriber, but one between, say, 50 or 60 subscribers; and although increased expenditure per subscriber was necessary in the shape of capital outlay on lines, while the application admitted at once of the simplification of the exchange room, the complication of lines was to a certain extent increased. The really interesting point in Mr. Bennett's paper was the discovery—he believed he was right in calling it his (Mr. Bennett's) discovery—that had been pointed out to them in diagram 4. It was a most interesting outcome of his investigations and experience, because, admitting that the Mann system was the best, this saving in a branch wire into every subscriber—in other words, four altogether to every subscriber's office—was an important factor in the success of the scheme. But Mr. Bennett did not give credit to one essential feature of the system. He (the speaker) advocated in 1883 at the Society of Arts, and pointed out that the great delay in telephone exchanges was due to a system which had been brought to this country by persons who had only started exchanges in America, and had not found out one fundamental error, and that was that all telephone exchanges were worked by the switch-room, that is, the central office having to call up a subscriber, and it was that which caused delay. But once the public had been educated to follow this system it was extremely difficult to change them. He advocated the closing of all the offices and starting anew. The success of Mr. Bennett's system was mainly due to teaching subscribers that it was their duty to call up their correspondent. As soon as they were taught to do that they would get rid of all delay. As soon as that was recognised in few exchanges, the rest would soon follow. There was no doubt that the simplification of the telephone in the future would be the double wire system, and also the essential part of the Mann system. Mr. Bennett described how the young lady in the switch-room had two little telephones attached to her ears, by which means she was placed in communication with 50 or 60 subscribers, and by which a considerable amount of the switch-room apparatus was saved. But when they came to consider what it would mean to have wires attached to one's ears in communication with 50 or 60 persons, he must say it was a very serious thing. Mr. Bennett told them that the young ladies had acquired the art of not going mad in a wonderfully short time, and if they began at 15 or 16, they would probably never have to be sent to a lunatic asylum. He must say that it was a detail to be overcome, no doubt, but it was likely to be problematical. Mr. Bennett told them that this difficulty of facing the demand for telephonic exchanges in large cities like London had never been faced before. He would remind him that in 1880, he—the speaker—had laid out the City of London for 200 exchanges, and plans were published at the time.

Mr. DAVEY said that Mr. Preece, who was responsible for overcoming the difficulties of the London-Paris line, had not told them all the difficulties. He would like to ask Mr. Preece whether one of the great difficulties was not that of sending a message through a submarine cable. He thought a mechanical illustration of assisted induction might serve to rivet on their minds the great benefit which had been derived from what Mr. Preece had told them was the greatest improvement in the system. He had shown them two diagrams, one to illustrate what he (the speaker) might call resisted induction, and the other assisted induction. If they drew two parallel lines and put two geared wheels between the wires and touching them (assuming them to be geared together), and applied force to the periphery of that wheel, it would resist a force which was applied in the opposite direction on the periphery of the other wheel. That was, if they put in an even number of wheels geared together, they had an illustration of resisted induction. But if they put in an odd number they got assisted induction.

Prof. SILVANUS P. THOMPSON said they were greatly indebted to Mr. Preece for his clear description of the London-Paris telephone, and he quite agreed with General Webber that they ought to credit Mr. Preece with a little more than his own modesty had claimed. He and his coadjutors in the General Post Office deserved great credit not only for the work done in this particular extension of the telephone, but for the work they did years ago—more particularly in Newcastle—when they led the way to the establishment of exchanges on a more rational plan than that which came over from America. They were so apt to think that American electricians led the way because they said so, and occasionally they were believed for want of further information. Now, the fact was that the English led the world in telephonic work, and not the Americans. Mr. Preece and the Post Office officials at Newcastle established a better way of laying out an exchange than the American plan, and their Scotch friends had still further improved on it. The British Post Office, moreover, had availed itself of still further improvements that had been made in signalling. He had the misfortune to differ from Mr. Preece as to the theoretical working of telephonic circuits, but that did not prevent him from admiring the good work he had done. Mr. Preece had said that he did not know to whom was due the credit of using a shunted condenser. He thought if Mr. Preece would refer to an old journal of Krellers he would find a paper by Helmholtz, about 1850, in which the effect of using a shunted condenser for stopping sparks, or the effects of electro-magnetic inertia, was clearly pointed out. He was glad that Mr. Preece had accepted the proposition that retardation due to induction was antagonistic in a certain sense to the retardation due to actual capacity. He had told them that a condenser properly shunted could be made to counteract the effects of self-induction. He wished that Mr. Preece would believe that induction could counteract the effects of capacity, and the reason why they could telephone through lines having capacity was because of induction. That rather difficult proposition was laid down by Mr. Oliver Heaviside, and he (the speaker) found it very hard, and he knew that Mr. Preece had not accepted it. Their attention was drawn to the very pretty mechanical method of illustrating assisted and resisted induction, he would point out that it had been given in Prof. Oliver Lodge's "Modern Views of Electricity." This showed them that the energy was not propagated up one copper wire and down another, but across the medium.

A MEMBER asked Mr. Bennett whether it was possible to reconstruct existing exchanges by substituting double wires for single without pulling them to pieces; or whether it would be necessary to do as they had done in Manchester, viz., make a new exchange altogether? In that case the enormously watered capital of the present National Telephone Company, which amounted to about 3 millions of money, would be absolutely useless. Would the present company be able to put up double wires without producing a loss of capital?

Mr. S. F. WALKER congratulated Mr. Preece on the results he had obtained, and asked if he had had any trouble with leakage on the London-Paris line. As to Mr. Bennett's paper, he had long been of opinion that the question of the increase of telephone exchanges must be faced sooner or later. As soon as the monopoly had fully expired, there was no doubt there would be an enormous development. Everyone would have telephones if they could have them cheap. But no matter how much branch centres were multiplied, the more the subscribers were increased the more they must multiply their connecting lines; and he thought when they got beyond a certain point the rate must go up or the dividend would go down, unless they could save the increased cost in another way. He was very pleased to find Mr. Bennett tackling the subject. Attendance was one of the biggest charges, and if Mr. Bennett could reduce its cost in the way he suggested without sending telephonic young ladies into lunatic asylums he would put universal exchange work several degrees forward.

Mr. BLAKESLEY asked as to diagram 4, in which Mr. Preece gave a longitudinal section of the line he had put the telephone at St. Margaret's Bay in shunt, and the telephone at Sangatte in shunt. If he (the speaker) understood aright, the St. Margaret's Bay telephone was in shunt when used to London, but when anybody was talking to Paris it was not necessary to shunt it. This was very interesting, but he thought that fact could not be taken as universally true. It would be better that telephones should be in series in other cases. The way to decide whether they should be depended upon certain properties of the cables. In fig. 1 there was some mistake. He supposed Mr. Preece did not mean that the current began to fall or rise suddenly and ended suddenly. It began gradually and reached its maximum gradually. He was very glad Mr. Preece had arrived at the principle of the use of the shunted condenser. He (the speaker

worked out the theory of the condenser in series and shunt circuit in 1884. Prof. Thompson had mentioned that somebody else had used a shunted condenser before, but he did not think they gave the theory of it. Sir William Grove made very remarkable experiments with a condenser, but it was for sending large currents into the primary of a Rhumkorff's coil by means of an electrical machine, and getting extraordinary sparks in the secondary. He knew the effect was produced by the condenser, but he did not attempt to explain it. He (the speaker) would have liked to have made further explanations. The whole thing was very interesting, but it required a better memory than he had to carry the facts of the case in his head.

Mr. GAVEY briefly described the Postal Telegraph Exchange system. A small shutter was held up automatically by the currentand a small indicating needle. If the renter wanted the attention of the telephone exchange, by pressing a button the shutter fell, and the ordinary connections were made. When the renter had completed his conversation, the mere act of restoring the telephones or tubes to the rests, sent an automatic current which, deflecting the needle in the indicator, advised the clerk at the room that the conversation was completed and the connection severed. Mr. Bennett suggested in his paper that electro-magnets introduced in a telephone circuit caused trouble, under certain circumstances. Yes; but they could always be so disposed as to cause no trouble whatever. His general experience of the introduction of electro-magnets in the Post Office system with indicators in short circuits, such as were used in towns, was, that they had no evil effect whatever. If they were introduced on long trunk lines the effect would be to very much dull the speech, and perhaps to render it utterly impossible. But this could always be overcome by using indicators of high resistance and great self-induction, and by bridging them across the line, much as they saw the telephones bridged across in fig. 4 in Mr. Preece's paper, instead of putting them directly into circuit. When that was done the effect on the speech was absolutely inappreciable. The rapid telephone currents did not traverse the indicators at all, whereas the slower ringing currents were distinctly felt. The system hitherto introduced into this country had always been to minimise, if possible, the number of exchanges in a town, because if these were multiplied delay was always introduced in putting one exchange in connection with another. With many exchanges the switch clerk had to connect a renter through his switch-room and through one, or, perhaps, two or three others, and when he was through the reply comes that the person wanted is engaged, and all the work is wasted; so that when they could have direct lines all centreing on one exchange, though the cost might be increased, the efficiency of the service was increased also. He would venture to say, therefore, that in all towns of moderate size the most efficient service on the whole would be one that centred the whole of the wires in the town into one exchange. In towns of enormous size the cost of a service of that character would be absolutely prohibitive. Mr. Bennett had indicated one method of multiplying exchanges which was certainly very promising, and might be developed later into a very useful system.

Mr. J. HEAD said Mr. Preece had shown them that telephonic lines of 500 to 800 miles could now be made and worked with perfect success. They were all very much interested in being able to talk from London to Berlin, and so on, but they were most of them still more interested in being able to talk from one part of their own country to another. 800 miles included the most distant parts of that country. Would Mr. Preece's experience encourage him to say that within a measurable distance of time the local exchanges in the country would be so connected as to enable them to talk with their friends wherever they might be in the United Kingdom?

A MEMBER asked what was the distance over which telephone messages could be sent in America.

Mr. WALLACE, alluding to the important remark made by Mr. Preece that in the future all telephone wires must go underground, said that this would take some time to do, but it must be one of the objects which all persons who wished to construct proper exchanges must have in view. Of course it could not be done by the National Company without expending a tremendous amount of extra capital, and doing away with practically the only asset they had left out of the money they had spent. Perhaps Mr. Preece would tell them whether it could be done by the Post Office? As to the inter-connection of towns, too, he would like to hear something from Mr. Preece. He thought they might take it that they would have to have metallic returns in the local exchanges, as Mr. Bennett had already pointed out.

Mr. PREECE, in replying, said he would take the questions put to him seriatim. Mr. Davey hinted that he did not refer to the submarine cable as an obstruction. As a matter of fact, he had done so, because he always put the cable as part and parcel of the whole circuit, and when he used the term K, he included that. Cables were a very great obstruction, simply because the electrical capacity possessed by them bore such a very large ratio to that possessed by the rest of the circuit. They had found that the 23 miles of cable across the channel had not been a great obstruction. In the case of a proposed circuit between London and Brussels, a cable of 60 miles would prove a rather serious obstacle. Prof. Thompson referred to "Kreller's Journal." He (Prof. Thompson) was a mine of information. If anybody wanted to know the history of any matter electrical, there was the man. If they wanted anything written about the history or the theory of electricity, there was their philosopher and friend; and although he had then heard for the first time that Prof. Helmholtz—the greatest living authority—had introduced matters relating to condensers, he would go to his friend and learn all about it in a very short time. Prof. Thompson accused him of not accepting or of neglecting something. All that he knew was that in electrical matters he invariably accepted truth. If it turned out that he was wrong, he willingly changed his views. But he had seen more nonsense written on that subject of self-induction than any other in the English language. And the reason was that the writers on electricity did not always apply the same term to the same thing. They were not even agreed as to the use of the simple letter L. It was not always used to imply the same thing, and the result was that some of Prof. Silvanus Thompson's friends might have used L to indicate the very reverse to what he (the speaker) did; he would find out from him, and if he was wrong, he would withdraw anything he had said. As it was, his paper said that there were conditions where inductions favoured the transmission of speech, and that was why they spoke so well. Prof. Thompson had referred to the assistance he (the speaker) had received from the Post Office officials in carrying those works out. He did not believe that in any service in this world there was a finer body of men than in that of the British Post Office, and if there was any branch in which their capabilities came to the front more than another, it was in the electrical branch. They had that day had some remarks from his oldest friend in the Post Office and his ablest assistant, Mr. Gavey, who had charge of the telegraphic arrangements in that part of the country, and there was no part of the country where telephony had been carried out to greater perfection than down there. All the towns of the valleys of South Wales, Swansea, Newport, Bristol, &c., were in direct communication with each other, and all the principles of clear speech had been carried out there in their highest order. In Newcastle, again, there was Mr. A. W. Heaviside, in Liverpool Mr. Edwards, and in London Mr. Cooper and Mr. Brown. The sole object of these men had been to benefit the public service, and to show that good work could be done. Prof. Blakesley did not understand diagram 1. It was an attempt to indicate the appearance of the current as it was received at the distant end of the circuit. For instance, if they sent a current from Ireland to America on the submarine cable, it was recorded by a Thomson recorder, and the line of the recorder was a curve very much like that. He had carried out a heap of experiments in recording telephone currents. They were so delicate that the absolute currents could not be recorded, but by the use of a very powerful primary current, and by the aid of recorders, they had been able to record speech. He was sorry to say that he had left these records behind him in London, but he would have very great pleasure in showing them to Prof. Blakesley. That mode—shown on diagram 4—was practically the only way of connecting up telephones to work. In that case they utilised the self-induction of air. Mr. Gavey had described how they connected up any number of telephones in bridge or shunt, so that intermediate instruments did not affect the circuit at all, but were assistant rather than resistant. Mr. Head asked a question as to the possible future of telephonic enterprise in this country. He was quite right; it was perfectly possible to connect together any two towns and to place them within decent speech of each other as good as that in London and Paris. But the obstacle was an important one. It was not L, electro-magnetic inertia, but £ s. d. The difficulty was not that that £ s. d. was not to be found in the coffers of Her Majesty's Government; but, as it happened, the telephone interests in this country were in the hands of private companies. It was for them to spend their money in carrying out long-distance circuits between town and town, unless the public through the House of Commons could show that they were better served by the Post Office, then, as a member of the Post Office, he (the speaker) would be only too glad to connect Mr. Head's town in the north with his town in the south. He thought he had answered Mr. Wallace's question, and as to Mr. Walker's, there was no doubt that leakage had a beneficial effect. He thought it was Mr. Oliver Heaviside who in one of his papers pointed out that the polarisation effect of leakage must have a beneficial effect, and no doubt it had, as they spoke better in wet weather than in dry.

In reply to another question—They did talk between New York and Chicago—a distance, he believed, of 800 miles—but he did not think it was commercial. He thought the greatest distance over which commercial speech was carried on was between New York and Boston—a distance of 300 miles.

Mr. BENNETT said he would begin his reply by apologising to Gen. Webber, for it was within his knowledge that Gen. Webber contrived and planned a scheme for telephoning London as far back as 1880. But unfortunately his advice on that subject was not taken, and the result was the fortuitous concourse of telephones now known as the London telephone system. Gen. Webber was under the impression that the young lady operators object to always listening at the telephones. The reverse was in fact the case. By the ordinary system the wants of the subscribers were made known by the dropping of little shutters, and it was necessary for the girls to be perpetually replacing these shutters after they had been dropped, and this was very fatiguing in a long day's work. With the Mann system all shutters were dispensed with. The girls had light telephones attached to their ears, their hands being free, and they had really nothing to do but to sit still, listen, and move their hands; whereas, with the American system, they had practically to be jumping about all day along. The skill attained by some of these girls was very marvellous. Some of them could actually take messages from two subscribers simultaneously, and understand them both. Gen. Webber thought that it would perhaps be very inconvenient if 50 or 60 calls came at the same moment. So it would, and he did not imagine they could manage 50 or 60; but as a matter of fact, such a thing never happened. When a subscriber put down his lever to give an order to the operator, should another subscriber have his lever down, the other instantly knew the fact. The formula for giving orders was a very short one; it occupied about one second. The calling subscriber gave his calling number, "400," and added "on 20;" that occupied but a very short time. Subscribers got into the habit of waiting for each other, and such a thing as 50 or 60 speaking together was quite out of the question. In reply to another question, he did not think it was at all possible for the National Telephone Company to alter their existing wires to metallic circuits. As

Mr. Preece had told them, not only was it essential to have a metallic circuit, but it was necessary to erect these circuits in a certain way, in order to get the benefit of the double wire. Now, it would be necessary for the present single wires not only to be doubled, but their position on the standards and poles would have to be altered entirely. So the cheaper method would be to take them down altogether and erect new ones. The company's present supports, poles and standards would come in, but the cost of changing single to double wires would, in his opinion, be as much as the construction of a new system would cost. There was another difficulty about it. It would be impossible to change the single wires into double ones at once. The process must go on gradually, and grave difficulties would arise because it would be necessary to still retain subscribers with single wires to speak to those who had double ones. This could only be done by the insertion of translators, of which a very large number would have to be provided, and the switching arrangements would be very gravely complicated. In 1883 he advised the National Company to effect such a change, but their wires were then few; now the aspect had changed altogether. Mr. Walker thought that the multiplying of trunk wires would be a very costly matter. Of course, they could not put down new junction wires without spending money; but then it must be recollected the necessity for these junction wires would not arise until the number of subscribers had increased. Every subscriber would of course pay an annual rental, and that annual rental would go to find the necessary dividend on the cost of new junction wires. He could say this with the greatest confidence, because he had had practical experience of the matter. Mr. Gavey had pointed out how it was possible to combine electro-magnets with telephonic circuits without spoiling the speaking. He did not say it was not possible to do that. What he said was, it was not done. The American system was followed in this country almost blindly without any alteration, and a part of that system was the introduction of electro-magnets on the wires at the switch-room. Every electro-magnet took away from the efficiency of speaking, so that with the present system, if several switch-rooms had to be spoken through, or several towns, the result would be that the efficiency of speaking would be perhaps altogether destroyed. He had known that expensive trunk lines between important towns 50 or 60 miles apart, costing thousands of pounds, had lain inoperative for months, simply because the American system of retaining magnets in connection with trunk lines was adhered to.

THE LIGHTING OF RAILWAY TRAINS ELECTRICALLY.

By J. A. TIMMIS.

(*Read in Section G, by Mr. Smith, August 24th*, 1891.)

IT is not advisable, here, to enter on any lengthened dissertation as to the relative merits of oil or gas or electricity as a means of lighting, as such, to be complete, would involve many intricate side issues connected with the expense of first cost, and the attendant and complex ones of maintenance and labour.

There can, however, be no doubt, and we may take it as generally admitted, that the light from oil lamps is not sufficient to supply the wants of the travelling public.

The light given by the most approved system of gas lighting is, undoubtedly, far superior to that supplied by oil lamps, but it is not equal to that given by high candle-power incandescent electric lamps.

The test which must be applied to any system of train lighting is a light equal to daylight on a fairly clear day, in other words, a light sufficient to enable anyone to read at night with the same ease and comfort that he can when travelling in broad daylight.

This is self-evident on reflecting that at most stations papers are sold, and that the sale of papers, periodicals and books on railways, has grown into an enormous trade.

Our experience after hard and anxious work, spreading over four years, gained from the lighting of some 300 carriages, most of them long bogie cars, is, that while it is perfectly easy to light any carriage or train successfully, and to give absolute and constant satisfaction to the railway authorities and also to the travelling public, it is a matter (now that is attained) of imperative necessity to give a system which is not extravagant in first cost, and is (and this is of far greater importance) economical in labour and renewals, *i.e.*, in working and maintenance.

We may lay it down as a law to begin with, that, in order to obtain the *greatest efficiency* and economy, a whole railway system must be lighted and not merely a portion of it.

But as it is most improbable that any large railway company would light the whole of its stock at once, it is an evident advantage to have a system which enables the stock to be fitted gradually.

Having stated these primary conditions, we will consider a number of other conditions which we find are imperative in detail.

(1) Each and every carriage must carry its own store or reservoir of electricity, because it may be attached to any train throughout the system, and then may be taken off or slipped from the train it is travelling with and attached to another (or the same) train at any important station, and while detached the carriage, if lighted, must remain so.

In addition to this:—

(*a*) The weight of the electric battery in each vehicle must be small, on account of weight and expense.

(*b*) The batteries must not be liable to be charged when the carriages are in regular work, neither must any carriage be detained at any point to have its battery charged.

Every carriage must be free to be used in traffic always.

(2) In order to give such an amount of light (as mentioned above) as shall be equal to daylight—

(*a*) The lamps used should be 16-candle power.

(*b*) The voltage used to drive them should be as high as practicable, because the consumption of electricity (a most important factor) is materially reduced. We find that 50 volts is the safest limit. The carbons of lamps of over 50 volts will not stand railway travelling.

(*c*) The reflectors should have a convex and diffusive shape.

(3) The light must be under the control of the guard.

There are three methods by which electricity may be generated for the lighting of railway carriages.

1st. By a dynamo driven from an axle of the train, and this is sometimes necessary but never advisable.

A dynamo must be driven from the axle in the case of a wagon-lits train, because this company does not own or work the locomotives, neither do they possess any rights in the railway stations. In addition to these conditions, the speeds of their trains are uniform and the distances between stoppages are very great, so that the conditions are not only special but as favourable for axle driving as they can be.

In Russia also, the very long runs and the low and uniform speed of trains, added to the difficulty of fixing a dynamo and engine on the locomotive, make it sometimes advisable to use axle-driven dynamos.

But under ordinary circumstances axle-driven dynamos are most objectionable, because—

(1) The field magnets have to be larger in proportion in order to deal with the increase of speed between that at which the dynamo cuts in to charge the batteries and the maximum speed of the train. This is sometimes as 1 to 3.

(2) The gearing is very soon worn and destroyed.

(3) A special set of skilled workmen have to be employed to keep them in order.

(4) Practically every van would have to be fitted with a dynamo, and also with a large battery. The expense entailed being beyond all reason, as, if there is a dynamo on the train, there should not be any electric battery to light the main lamps.

2nd. Another method is to drive a dynamo on the train by a special engine, using locomotive steam (in special cases we have used a special boiler in a very large van, but the circumstances were exceptional, and the objections to its general use are so obvious that it is not necessary to mention it further).

3rd. The third method for the generation of electricity is to employ a plant at certain important stations to light the stations and yards, and at the same time to charge the batteries used in lighting the trains.

These two latter systems each have their advantages. With a dynamo and special engine on the locomotive—

(1) Which are self-contained, and which only vary less than 1 per cent. in speed, with a variation of up to 50 per cent. in steam pressure, *i.e.*, which are constant in speed and also in electrical efficiency.

(2) Which are not over 3 ft. 6 in. high by 4 ft. by 2 ft.

(3) Which start automatically when steam is turned on.

(4) Which are boxed in from dust and wet, and do not heat.

(5) Which do not require lubrication for several days when in constant work.

(6) The locomotive driver has very little extra work and no attention to give to this.

And we have obtained all these points.

It is clear that the generation of electricity for lighting trains becomes simple and economical, especially when—

(*a*) The high voltage necessary to run the lamps efficiently and economically can be readily obtained.

(*b*) A main battery is not necessary by our system.

(*c*) As will be seen hereafter the total weight of batteries on a train of 12 long bogie cars is only about 1 ton.

On the other hand, if the main lighting is effected by main batteries in the vans, and they are charged at central stations by large plants which also light the stations, the following economies are effected:—

(*a*) A few large plants serve to generate the electricity required to light all the trains on a railway system, and also to light the stations, instead of a large number of small ones.

(*b*) A few skilled men only are required.

(*c*) The deterioration of large plants is much less than in the case of dynamos on the trains.

(*d*) The efficiency and economy of large plants is proportionately greater.

We come now to the point where it is necessary to describe the arrangements which we find most suitable and economical for carrying out the above conditions, and getting over all difficulties.

We fit the carriages with 16-candle-power 50 volt lamps, and we light these lamps either with a special engine and dynamo on the train, or with a battery consisting of 26 "accumulator" cells placed in the guard's van. These lamps, which we call the main lighting lamps, consume ·6 of an ampère each, whereas a 32 volt lamp consumes over an ampère. This is a very great advantage and economy in the working of railways. The extra number of cells, viz., 26 as against 18, being far more than counter-balanced by the saving of nearly 50 per cent. of electricity (*i.e.*, cost of charging and weight of lead per cell), and the increased amount of light.

But as each carriage has to carry its own storage of electricity for the reasons stated above, and it is not practicable to put 26 (or even 18) cells in each vehicle, because of—

(*a*) The weight.

(*b*) The first cost and maintenance.

(*c*) The difficulty to charge them with a dynamo on the train, and impossibility to do so with central charging stations.

We have worked out and patented all over the world (even in Germany and the United States our claims have been fully allowed) the following arrangement, our main object being to minimise the weight and cost of electric batteries.

In addition to the main lighting, we place small voltage lamps (8 volts we find sufficient) in the carriages and a small 4 cell accumulator battery in each carriage to light them. The leads and couplers and switches will be described presently.

These small lamps may be separate from the main lamps, but we have patented and are regularly using lamps with two filaments in. These lamps are shown in Messrs. Edison and Swan's catalogues and in the drawings herewith. They are so arranged that as soon as a pair of couplers are separated they are automatically lighted in the carriages that are separated from the main circuit, by the small batteries. They are also under the control of the guard.

The small batteries are very light (weighing per carriage less than 1 cwt.), they are not costly, and they are kept charged by the engine and dynamo or the main battery in the guard's van as required. Thus every carriage is free to be used in any train, and the only batteries that require special arrangements for charging, if any, are those in the guard's vans.

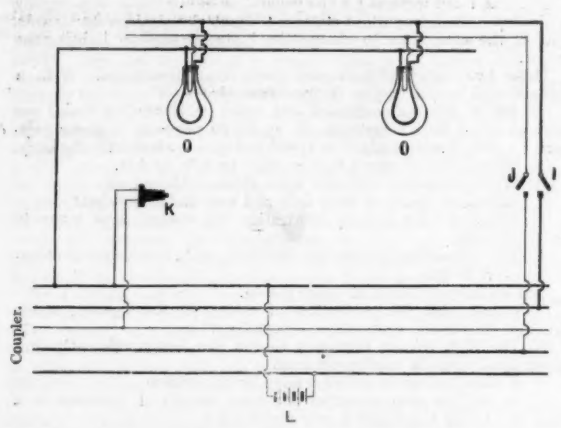
In order to effect the charging of these at central stations, we designed, some three years since, special light trucks, with the top flat platform adjustable as regards its height, and sufficiently large to hold two complete main batteries.

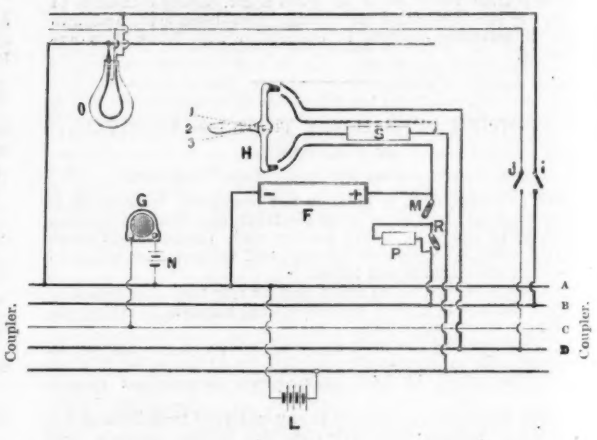
One of these trucks takes a freshly charged battery at a charging station, to a guard's van, receives the battery from the van, and the fresh one is put into its place. The contacts are made automatically.

It must be remembered that the only times the auxiliary lamps are used are when a vehicle is taken off a train and perhaps put for a few minutes, at the longest, into a siding and then joined on to another train, or when a vehicle is slipped from a train and while it is brought to a stop at a station, and during this time the auxiliary batteries give 6 to 8 candle-power in each auxiliary lamp.

In the case of division of a train, for instance where a long train of some twenty or more coaches splits up into say three divisions, then each division has at least one guard's van, and so it is, electrically and otherwise if main batteries are used, a complete train; and if special engines and dynamos are used, the lighting is equally complete.

Having described the main conditions which we find necessary to fulfil, and the general mode of dealing with those conditions so as to give an economical and efficient system for lighting railway trains, we will describe the drawings and diagrams in order to make the details of working of the two last systems clear.





There are two diagrams.

First, the larger one, explaining the "four wire" system.

The 5 leads, A, B, C, D, E, run throughout the whole length of the train, and are joined up from carriage to carriage by the couplers.

A, is the main negative. B, is the main positive from the large battery, F, or from the dynamo with its special engine. C, is the communication positive wire. D, is auxiliary lamp main lead, and E, is auxiliary battery main lead. It is evident that if D and E are joined, the auxiliary lamps will light up, provided the local switches J, J, are closed. F, is the main battery of 52 volts. G, communication bell. H, auxiliary battery three position switch. J, J, auxiliary lamps local switches. I, I, main lamps local switches. K, communication push. L, L, auxiliary batteries (it is possible to do without the auxiliary battery in van). M, main lighting switch. N, bell battery. O, O, main lamps with auxiliary filaments (the auxiliary lamps may be separate from the main lamp).

Before describing the action of the system, I may say that safety fuses are fitted in every carriage, but these have not been shown in the diagram in order not to complicate it.

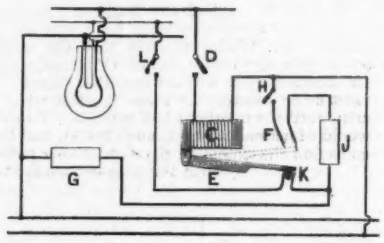
As will be seen from the diagram, when the train is coupled up the whole of the main lamps are lit from the battery, F, which is switched on to the circuit by switch, M (in combination with a switch, R, and resistance, P, to equalise the discharge). There is also a local switch, I, in each carriage, which governs the lights in each individual carriage without interfering with the rest of the train. The same action takes place if there is a dynamo on the locomotive instead of a main battery.

The charging of the auxiliary batteries is effected from the main battery, or from the dynamo on the locomotive as follows:—The switch, H, is placed in position 3, and the current flows through, S, to all the small batteries in the train in parallel. The resistance, S, being adjustable to the number of batteries in the train. When H is in position 1, the auxiliary lamps are lit from the auxiliary batteries. This is necessary, for example, in the case of changing the main battery at a station. The small batteries can, of course, be charged in series if it be found desirable.

The communication system, with its push, K, in each carriage or compartment, its main lead, C, bell, G, and small battery, N, is self-evident and needs no explanation. It may be worked by the main battery if desired.

The action of the automatic coupler strips, D, E, is as follows:—Should the train be parted anywhere, the strips, D, E, in the couplers that are severed, come down on to the piece, J, fig. 1 (coupler drawing), and the lead, D (diagram), is thus connected to lead, E, and the current thus flows from the auxiliary batteries, to the auxiliary lamps. When the train is once more coupled up, the connection is broken at the piece, J (coupler drawing), and the main lighting leads then come into action, and the auxiliary lamps go out.

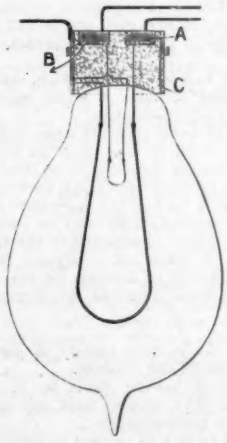
The smaller diagram represents the working of the same systems by the use of two through leads instead of four. This we consider equally efficient and more economical.



The main lighting current from main + B passes round coil, C, and, when switch D is closed, lights the large lamps or filaments, and in passing round C it actuates armature E, raising it and making contact F, and holding it there during the whole time main lamps are lit. The auxiliary battery, G, is thus placed in communication with main + by means of the switch, H, which, when closed, charges the auxiliary battery through the resistance, J.

When the lighting circuit is broken in any way, the current in C is also broken, and the armature, F, falls and makes contact, K, and the auxiliary switch, L, being closed the auxiliary lamps light up. When the main lamps are once more lit the auxiliary lamps are automatically put out by the action of E.

Double filament lamps (see drawing)—the large + is connected to piece A, the small + to piece B, while the brass casing, C, forms the common negative to both filaments, and this casing makes contact



with the lampholder which is attached to the general negative main.

The couplers for the "four-wire" system (see drawing).

Fig. 1 shows cross section of the coupler.
" 2 " longitudinal " "
" 3 " sectional plan " "

The five strips correspond and are attached to the five leads A, B, C, D, E, respectively, shown on main diagram, &c.

The strips are all pivoted on the pin, F, and are all insulated from it and from each other by the insulation shown in black. The pin, G, carries upon it the insulating piece, H, upon which the three strips, A,

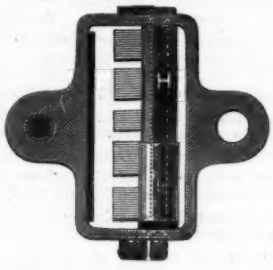


FIG. 1.

FIG. 2.

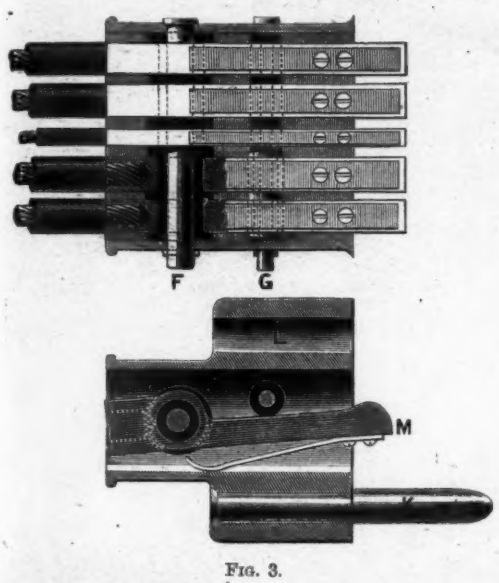


FIG. 3.

B, C, rest when the couplers are detached, and it also carries the brass piece, J, which is itself insulated from the pin, G. The object of the piece, J, is to automatically connect the two strips, D and E, when the couplers are separated, and thus light up the auxiliary lamps, as shown on diagram of general arrangement.

The pin, K, entering the hole, L, of the corresponding coupler, ensures the accurate meeting of the various strips and prevents short circuiting. As the couplers are pressed together, the curved ends of the strips engage with each other and hold the couplers together.

The springs, M, keep the strips in connection with their corresponding strips, or with the piece, J, when advisable.

If the two-wire system is used, only two strips are necessary.

In conclusion, we would remark that we can only claim as absolutely new in principle (as apart from the details of couplers and double filament lamps and other mechanical matters) the combination of a main lighting circuit with high E.M.F. and efficient economy, together with an auxiliary lighting circuit and lamps with small batteries and economy in weight, cost and maintenance.

DISCUSSION.

Mr. KILLINGWORTH HEDGES thought that the subject of train lighting was one of great importance, and it was to be regretted that Mr. Timmis's paper did not come on earlier in the day, when more attention could have been given to it. With the main conditions laid down by Mr. Timmis, particularly the one which stated that every carriage ought to carry its own store of electricity, he cordially agreed, in fact, he had advocated the same plan three years ago at the British Association meeting at Manchester. He must say, however, that it had been rather difficult to convince the railway authorities that they must, in order to break up their trains, put a battery in each carriage. It appeared to him that the main circuit and the auxiliary circuit, when connected, must be a very complicated system, and, indeed, one that would be difficult to arrange, unless rolling stock were joined together. He could not see the good of the auxiliary circuit, because, if they lighted with batteries connected up in a carriage, why not put in batteries of small capacity, perhaps three or four hours' storage, and work them from the dynamo, which, in ordinary times, when the train is in motion, lights the whole installation. The auxiliary limits of lower candle-power would offer grave objections, because people would sooner do without the electric light than have it suddenly lowered. In his (the speaker's) paper at Manchester, he mentioned batteries having zinc and lead electrodes. Since then not much had been done with them, but the other day, when seeing Mr. Webb, of the North Western, he was told that they were acting extremely well, experimentally. If such cells were used, they might obviate the difficulty complained of by Mr. Timmis in ordinary secondary batteries. At any rate, he thought it would be quite practicable to put a set of batteries, either of zinc and lead or the ordinary batteries, in a carriage, and get sufficient capacity to attempt all the lighting during ordinary stoppages at stations. One great objection to heavy batteries was the liability to be broken. When travelling on the Midland the other day, where a good system of electric lighting was used, he found the electric light was not at work. Upon asking the reason, he found that the train at one of the stations ran into the station buffers with sufficient force to knock the batteries out of the case and break it, and the orders were that until it was put together again not to use the dynamo. On the Midland they had tried successfully a very important experiment, and that was one advocated at the B.A. by Mr. Preece. It was known as Mr. Barber Starkey's plan, and consisted of filling up cells with plaster of Paris, and making them quite solid, and he was told that it acted admirably. In conclusion, the speaker expressed confidence in the fact that electricity must very soon be the illuminant used for trains, and pointed out the disastrous consequences of a collision between trains lighted by gas.

Mr. C. H. W. BIGGS said he was inclined to think that Mr. Timmis might tell them something about lithanode, which he believed Mr. Timmis had tested. The use of this gave a much less weighty battery, and gave better results. Recent improvements had made that material one of the best with which they were acquainted. There was an accumulator recently brought out which was solid, and which could apparently stand severe knocking about; in fact, he (the speaker) had seen one knocked about the room without taking harm, so far as one could see. In his opinion, if accumulators were to come into use for lighting railway trains, or for use in boat work or traction work, it must be of those forms.

Mr. BENNETT referred to a system of lighting used on the North British Railway.

Mr. SMITH, in replying for Mr. Timmis, said in reference to Mr. Hedges's objection to heavy batteries, it was that very reason which impelled Mr. Timmis to put in small batteries in each carriage. Mr. Hedges did not quite see that with that system no dynamo was used. If there was a large battery, then there was no dynamo. It amounted to this; if they had a charging station where they lighted the railway station, one used the same plant to charge the big battery in the guard's van. If the big battery was employed to light the main lights, then only little batteries were required to light the auxiliary lights, these could be left in the carriages from one month to another with only occasional supervision, because they were charged from the big battery. As to the diminution of light, it was not so serious as Mr. Hedges supposed; the reduction was from 16 C.P. to 10 C.P., which was quite good enough to read by. This, however, only occurred in stations, and it was supposed that the diminution of light here would not be very noticeable, at least, it would form no serious inconvenience. The speaker, in conclusion, gave Mr. Timmis's experience of the batteries mentioned by Mr. Hedges and the lithanode mentioned by Mr. Biggs, which was not such that enabled him to place confidence in them.

ON THE MAGNETIC FIELD IN THE NEIGHBOURHOOD OF THE SOUTH LONDON ELECTRICAL RAILWAY.

By Profs. W. E. AYRTON, F.R.S., and A. W. RUCKER, F.R.S.

(*Read in Section A, August 25th*, 1891.)

IN the spring of the present year we were both interested in the question as to how far the work of a physical laboratory would be affected by the neighbourhood of an electric railway.

The South London Electrical Railway runs from Stockwell to the City. It is constructed under the public roads at a depth of 60 or 70 feet below the surface. The up and down lines are carried in separate tunnels and enclosed in large iron tubes. The current is conveyed to the trains by an insulated rail, and the circuit is completed through the rails on which the trains run, which are therefore in connection with the iron tubes and thus end the earth. Our observations were made at a house No. 122, in Park Road, under which the railway runs, in two rooms at points distant about 60 feet and 200 feet from the middle of the road respectively.

The instruments used were (1) a rough magnetometer, consisting of needles attached to a mirror suspended by a silk thread about 3 inches long, and (2) an ordinary Elliott's square pattern mirror galvanometer which was used as a magnetometer.

All observations were made when the period of vibration of the instrument used was about 10 seconds. To compare the magnetic disturbances with those due to mere mechanical vibrations the magnets were removed from another similar galvanometer and replaced by copper rods of about the same mass. The mirror was then suspended by a bifilar, which gave a period of about 10 seconds. This was only intended to detect the effects of shaking on the galvanometer, and it may be sufficient to say that it proved conclusively that at Kennington Park Road the tremors due to the traffic might be almost neglected as source of disturbance when compared with the magnetic effects of the railway.

The latter were continuous, very great, and on one occasion when the line was blocked the instruments were at rest. The oscillations began again at or within a few seconds of the time when a train which had been detained in the neighbouring station had left it. This coincidence was most satisfactorily established as some of our party were noting the times of the arrival and departure of the trains, while others were also noting the instants at which the largest disturbances of the instruments occurred.

The passage of a train caused a very sudden disturbance of the needle, especially in the room nearest the line; but the amplitude of these vibrations, though greater, was often not much greater than that of those which were continually occurring at other times. At the stations 60 feet from the middle of the road, the larger deflections produced on a scale 1 metre distant from the instruments, were about ± 20 mm. At the more distant stations, about 200 feet from the road, they were about two and a half times less.

As the instruments were about 10 feet above the roadway, and probably about 70 feet above the line, the distances from the line at the two stations were about $\sqrt{60^2 + 70^2}$ and $\sqrt{200^2 + 70^2}$, or 92 and 212 feet respectively. The ratio of these numbers is 2·3, and as the ratio of the disturbances at the two stations was about 2·5, it is evident that they diminish very slowly as the distance increases. The law of the inverse distance was apparently approximately fulfilled. To show the effects of the railway, we publish the comparative diagram in figs. 1 to 4.

Readings were taken every 10 seconds of a Elliott's galvanometer, arranged as above described, in:—

1. A laboratory of the Royal College of Science, about 150 feet west of the middle of Exhibition Road.

Abscissæ 3 c.m. = 1 mm.
Ordinates Deflection on Natural Scale.

2. Another laboratory about 70 feet east of the same road.

3. A room at Kennington Park Road, about 200 feet from the middle of the road.

4. Ditto, 60 feet from the middle of the road.

Figs. 1 to 4 show the results at each place, 3 cm. corresponding to a minute, and the ordinates being the actual deflections observed.

The inequalities in fig. 2 were no doubt due to a dynamo which was working at some distance. Figs. 3 and 4 show the effects of the railway, and prove conclusively that ordinary students' work would be impossible in its neighbourhood.

To emphasise the fact that the standard of sensitiveness adopted was very moderate, we may mention that one of the instruments, arranged as for the experiments, was compared with a small magnetometer constructed by Prof. Boys, F.R.S. The latter instrument was found to be 160 times more sensitive than that employed in the observations just described.

Report (provisional) of a Committee, consisting of Professors M'LEOD and W. RAMSAY, *and* MR. W. A. SHENSTONE (*Secretary*), *appointed to investigate the Influence of the Silent Discharge of Electricity on Oxygen and other Gases.*

Section B.

THE Committee regrets to state that, owing to various circumstances, very little further progress has been made during the past year. The necessary means for securing assistance in part of the work have, however, lately been secured, and its continued progress may therefore now be looked for; and it is recommended that the Committee be re-appointed.

No grant is asked for, as the necessary apparatus is at the command of the Committee.

NEW PATENTS—1891.

14,097. "Improvements in telephone transmitters, and the methods adopted for the transmission of articulate speech, musical and other sound waves." H. L. TODD and J. TODD. Dated August 20th.

14,134. "Improvements in thermo-dynamic machines, and in apparatus and appliances connected therewith." W. H. WATKINSON. Dated August 21st.

14,150. "Improvements in electric fire detectors or alarms." H. MORGAN. (Communicated by C. Dion, France). Dated August 21st.

14,171. "An improvement in car conductors from overhead for electric cars." G. S. GRIMSTON. Dated August 21st.

14,217. "A new or improved printing telegraphic apparatus." S. GOSPARB and L. GIACOMINI. Dated August 22nd.

14,234. "Improvements in and relating to electric railways." M. CATTOBI. Dated August 22nd. (*Complete.*)

14,238. "An improved method of insulating and laying electric light conductors under ground." J. FARQUHARSON. Dated August 24th,

14,266. "Improvements in appliances for the administration of electricity to horses for curative purposes." M. HUMM and A. E. HUMM. Dated August 24th.

14,273. "Transmitting signals by means of an electric current, known as 'Shadowgraph.'" G. W. HART. Dated August 24th.

14,295. "Apparatus for protecting electric installations for telegraphic, telephonic, and lighting purposes from the effects of lightning or discharges of atmospheric electricity." G. W. SPITTLE. Dated August 24. (*Complete.*)

14,322. "Improvements in portable electric light holders." W. W. SAVAGE. (Communicated by W. W. Savage, Canada.) Dated August 25th. (*Complete.*)

14,345. "Improvements in telephones." C. VOGT. Dated August 25th.

14,379. "Improvements in methods and apparatus for giving increased life and efficiency to arc light carbons." N. M. GARLAND. Dated August 25. (*Complete.*)

14,386. "Improvements in or appertaining to electric motors." G. C. DYMOND. (Communicated by L. Gutmann, United States.) Dated August 25th. (*Complete.*)

14,388. "Improvements in and relating to electric motors." G. C. DYMOND. (Communicated by L. Gutmann, Germany.) Dated August 25th. (*Complete.*)

14,390. "Improvements in dynamo-electric machines." S. Z. DE FERRANTI. Dated August 25th.

14,391. "Improvements in couplings for insulated electrical conductors." A. SHEDLOCK. Dated August 25th.

14,397. "Improved electric wire insulating composition." J. S. PALMER and F. S. PALMER. Dated August 26th.

14,409. "Improvements in microphonic transmitters." G. BINSWANGER and H. J. COATES. Dated August 26th.

14,444. "Improvements in apparatus for the supply of motive power to electric generating stations and other works." G. FORBES. Dated August 26th.

14,462. "Improvements in electrical appliances for automatically specifying any pre-determined temperature." E. SMITH. Dated August 27th.

14,508. "An improved arc lamp." J. S. WARBURTON. Dated August 27th.

14,509. "Improvements in electrical transmission of power." B. J. B. MILLS. (Communicated by H. W. Leonard, United States.) Dated August 27th.

14,517. "Improvements in microphones." SIEMENS BROS. & Co., LTD. (Communicated by Siemens and Halske, Germany.) Dated August 27th.

14,518. "An improved construction of primary battery." H. WEYMERSCH. Dated August 27th.

14,520. "Improvements in electroliers." J. COLLINS. Dated August 27th.

14,525. "Improvements in electric safety lamps for mines." C. N. GAUZENTES. Dated August 27th.

14,585. "The use of asbestos in the working of electrical fittings." R. H. NEWINGTON and E. PRIDDLE. Dated August 29th.

14,596. "Improvements in telephonic switching apparatus." E. F. FURTADO and GRIST and TURNER. Dated August 29th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

2,945. "Improvements in and relating to and in the manufacture of electric secondary cells." A. M. F. LAURENT-CELY and I. A. TIMMIS. Dated February 24th. 11d. The inventors melt chloride of lead and then add as much as 25 per cent. of pure metallic zinc. The heat in the furnace they prefer to have as high as 550° C. The fused mixture is then run into a receiver and they find it an important feature to make this receiver sufficiently large to enable the impurities to fall to the bottom and so that the fused body forms a store of heat. The mixture is then poured into suitable moulds and cast into any required forms. The castings are then taken from the moulds and are treated as follows:—After being washed in a cold concentrated solution of hydrochloric acid the negative forms are washed in pure water and afterwards dried. They are then placed in moulds and spaced and when the moulds are closed pure lead with 5 per cent. to 7 per cent. antimony is run in and forms a framework and also a tang. These moulds are lined with asbestos packing. These negative plates are now put into suitable boxes with zinc plates. Each set coupled and then the two sets short circuited, the solution being pure cold water with a few drops of hydrochloric acid. This operation ceases when heat ceases to be given off and when the active material is soft and perfect. It is now cellular lead, with a density of 3 to 3·5. The plates are then washed in pure cold water. The positive forms are placed on zinc plates in pure cold water with a little hydrochloric acid till they are thoroughly transformed into metallic cellular lead and are then washed in cold water. They are then heated at a moderate heat in contact with air which is increased up to 300° C. when the pastiles become cellular litharge with a density of 5, which is about one-half the density of any other active material. 8 claims.

3,900. "Improvements in insulation and cooling of electrical inductoria." L. PYKE and H. T. BARNETT. Dated March 12th. 6d. The inventors construct the apparatus with all or as much as possible of the mechanical insulation of a permeable character, such as paper, and after being thoroughly dried, they place same in a container and complete the insulation by pouring in a liquid insulator, such as paraffin (which they prefer), which may have first been dried, by passing through a filter of powdered potassium, or by some other convenient method. 5 claims.

4,821. "An improvement in insulated electric conductors." E. F. A. OBACH. Dated March 27th. 4d. The inventor coats the wire with some gelatinous substance such as glue, isinglass or the like, either alone or together with a serving of some fabric such as paper or textile material. The vulcanised material can then be applied directly over the wire thus coated, without requiring any other separating materials. For the protection of the sheathing against sulphur the insulated wire is similarly coated with gelatinous material. 1 claim.

5,409. "Improvements in electrical arc lamps." S. CAPPELLERI, C. KURMAYER, J. GOLDBERG, and R. LATZKO. Dated April 9th. 8d. Relates to an electric arc lamp, in which both carbons are formed as the ends of rotatable archimedian spirals, and are connected either with the same, or with a body substituted therefor, so that on the burning away of the carbons the state of equilibrium is automatically maintained by the turning of both spirals, or of the body substituted therefor, thus also maintaining the distance between the carbon points. 2 claims.

6,223. "Improvements in galvanic batteries." M. ANCIZAR. (A communication from abroad by R. Zerda-Bayon, of South America.) Dated April 23rd. 6d. Claims:—1. A galvanic couple whereof the anode is of carbon surrounded by a mixture composed of a porous earth containing vegetable or nitrogenous substances and a soluble salt, preferably chloride of sodium, the whole contained in a porous vessel which is immersed in an electrolytic liquid, preferably a saturated solution of chloride of sodium, wherein a zinc cathode is also immersed, all substantially as described. 2. A pocket dry pile consisting of a carbon anode and zinc cathode, separated by a fabric and surrounded by moistened porous earth containing vegetable or nitrogenous material and a soluble salt, preferably chloride of sodium, the whole being contained in a soft India-rubber bag, as described. 3. The use of a porous earth impregnated with vegetable or animal nitrogenous material in combination with chloride of sodium or sulphate of alumina in the manufacture of galvanic cells or piles, substantially as described.

6,623. "Improvements in switches for controlling electric currents for lamps and other purposes." J. WARDEN and G. SMITH. Dated April 30th. 6d. Claims:—1. A direct acting spring or bridge to make or break the contact between the electrodes. 2. Control of the spring or bridge by the cam, lever, or other device, without the aid of coiled springs. 3. The contact is made or broken by the one motion of rotation only, applied to the plug as in an ordinary gas tap.

6,924. "Improvements in electric batteries." H. T. EAGAR and R. P. MILBURN. Dated May 5th. 4d. Relates to the use of aluminium as one of the electrodes or poles in the construction of batteries or elements, and has for its object to produce batteries which are especially suitable for portable electric lamps, for instance, miners' lamps.

7,422. "Improvements in appliances used for regulating or cutting out an electrical circuit." F. BRYAN. Dated May 13th. 6d. Claim:—An appliance for cutting out an electrical circuit when the current exceeds a certain strength, wherein a wire coil enclosing an adjustable magnetic core and forming part of the circuit while it is in a certain position, is pivoted so that when the strength of current causes a certain amount of mutual attraction between it and the core, the coil is made to move out of position and so to open the circuit, substantially as described.

7,520. "A method of signalling on electric lighting circuits." W. C. JOHNSON and S. E. PHILLIPS. Dated May 14th. 4d. Claim:—A method of utilising the ordinary electric lamps on electric lighting installations for signalling purposes, consisting in effecting a momentary increase or decrease or cessation of the light of such lamps by means of a suitable switch or other device at the central station, whereby the electrical energy passing through the lighting mains can be momentarily increased or intercepted, either automatically or otherwise, such momentary variations in the light being made to take place either in succession according to any signalling code, or at certain times of the day to indicate correct time, or for other signalling purposes.

7,624. "Improvements in electrical transformers." J. A. KINGDON. Dated May 16th. 8d. The inventor constructs the cores of the improved transformers of a number of thin plates of soft iron piled one above another. These are of the same width, but at intervals one or two are longer than the rest. Insulating material is wrapt round the pile of plates, and primary and secondary coils of insulated conducting wire are then wound outside the insulating material. Outside the wire coils, and separated from them by insulating material, or an air space, are wound a number of coils of thin iron strip or ribbon. These coils are in contact with and wound round the projecting ends of the iron cores, and are at right angles to the wire coils. They are separated from one another by the longer plates of the cores. Bolts pass through these plates, outside the ribbon coils, and clamp the whole together. Metal covers are bolted over the projecting wire coils, or the transformer is placed in a metal box. 6 claims.

REVIEWS.

The Elements of Dynamic Electricity and Magnetism. By PHILIP ATKINSON, A.M., Ph.D. London: Crosby Lockwood and Son, Stationers' Hall Court, Ludgate Hill.

This book (by an American author) possesses no remarkable features calling for special attention, and being written by an American, naturally is tinged with the nationality of the writer, this being more especially noticeable, as might be expected, in the chapter on the electric telegraph. Had no other treatises existed of the kind, we should have said that the book was a decidedly valuable addition to the electrical library. We can certainly say, however, that such as it is it is good, and deserves success. It is well printed and well illustrated.

Annales Télégraphiques. Table Générale des Matières et des Auteurs. Années 1855 *à* 1890. By H. PELLETIER. Paris: Vve. Ch. Dunod, Editeur, 49, Quai des Augustins.

This index of Annales Télégraphiques has been compiled by order of the Directeur Général des Postes and Télégraphs. It is really a very valuable work of reference, and should be possessed by every one interested in telegraphic and telephonic matters.

Dictionnaire d'Electricité et de Magnétisme. By JULIEN LEFEVRE. Fourth part. Paris: J. B. Baillière et Fils, 19, Rue Hautefeuille.

This volume, continuing the subject of the electric telegraph, the Hughes printer and its modifications chiefly being considered, has sections on the telephone, transformers, tramways, and other important subjects; the part concludes with a supplementary section, containing, amongst other things, further information on the subject of dynamo machines and central stations. Altogether, the four parts, of which the present is the last, form a very useful compilation, carried out with remarkable ability.

CORRESPONDENCE.

On the Telephoning of Great Cities.

I saw in your issue of September 4th a very interesting paper by Mr. A. R. Bennett, read before Section G, August 24th, and I should feel obliged if you would kindly allow me a small space in your next issue to make a few observations on same.

In the first place, I may mention that I have had no practical experience with telephone metallic circuits on a large scale, and I may pertinently ask—without fear of being answered in the affirmative—who has? The experiment has yet to be tried; but as regards the Mann or Law systems, as they are practically identical, I should like to say a few words. In the first place, it is very risky for a large telephonic system to be entirely dependent on a few "call wires"—or shall we call our old *bête noire* by its new name, service wire—for should one of these wires break, or become faulty before reaching the first subscriber on a section, the whole of the subscribers on that section are entirely cut off from the exchange—say 60 or 100.

Wherever the fault occurs, all the subscribers beyond it cannot use their telephones, and should these faults be of the "peculiar" kind, it may take some time to find them, whereas, with the annunciator system, each wire being separate, only the subscriber on the faulty wire is affected.

Operators at each switchboard or section listening to, say, 60 or 100 subscribers, have also their trunk wires from section to section to attend to, and I fail to see how they can attend promptly to all at the same time. I have known as many as nine or ten calling out their numbers and the numbers they wish to be connected to; then comes the trouble, and the subscribers get angry with the system, for the operators cannot with certainty, however experienced and smart they may be, catch the correct numbers, and have to make the oft-repeated and annoying request to subscribers, "One at a time, please, one at a time," which is so familiar to those who have used the "call wire system." Again, how can one subscriber know that another is pressing his lever at the very moment that he does the same thing, and speaks quickly without listening.

The "call wire system" I admit is the most rapid for small exchanges, but I beg to differ with Mr. Bennett's assertion that the larger the switch-rooms become the system shows to better advantage, as nearly everyone who has worked this system in a growing telephone district has observed that the result is quite the contrary, and that the "call wire system" is altogether inadequate for large telephone centres. In 1883 I had charge of a "Law system" in India—the only difference between that and the one proposed by Mr. Bennett being the absence of metallic circuits for subscriber's private lines, and I was at first inclined to think it the best that could possibly be obtained, but as the number of subscribers increased I began to think otherwise, the call wires continually giving trouble electrically, and frequent muddles also occurred in switching. I hear that since my return the system has been changed to the "magneto annunciator" system.

In New York, with its enormous telephonic centres, there is only *one* small exchange on the Law system, and even though the subscription to this is much less than to the "magneto system," the subscribers to the former are rapidly changing over to the latter, and paying the difference, which is much appreciated by those operating the exchanges.

If this "call wire system" is so much superior, as Mr. Bennett would have us believe, why is it being discarded at so many exchanges, which have given it a long and fair trial in many parts of the world, and is now in a fair way of becoming obsolete?

The operator would, I fear, have to keep on the head-gear all the time she was manipulating the call wire—(and I doubt if she would like this, however pretty and attractive the ornament might be)—for should this get accidentally "earthed" the signal would be affected, but the operator would hear no voices, hence the signal could not be relied on.

Mr. Bennett's remarks about the American system appear rather vague; if he has visited and inspected an American exchange he has formed a very different opinion to myself, and, I feel justified in saying, a very erroneous one.

H. Goodwin.

September 8th, 1891.

Electrical Standards.

Now that the report of the committee on the "Standards for the Measurement of Electricity" has been issued, I—and probably many of your readers as well—would be glad if you would either explain in a practical manner, or mention any books in which a practical explanation is given of resolutions 11 and 15 of the report.

I cannot understand what is meant by the "square root of the time average of the square of its strength (or value) at each instant," and if you could spare sufficient space in your valuable journal to explain the above and give one or two examples I, for one, should be greatly obliged.

Student.

September 2nd, 1891.

[We are not aware of any book in which any explanation is given of the meaning of the resolutions referred to. The subject is not one which is easily grasped or explained, but perhaps some one of our correspondents could write a lucid statement of what is asked for.—EDS. ELEC. REV.]

The Edison Dynamo.

In reply to Mr. S. W. Cuttriss's request that we should state the voltage of our "Infant" dynamo, we give the following particulars of a No. 4 we supplied to Mr. F. I. Parson, Cape Town, S. Africa. This is shunt wound for charging accumulators. Resistance of field magnets, 27·72 ohms. Resistance of armature, 0·271 ohms. This machine, at a speed of 1,900 revolutions per minute, gives 12 ampères at a pressure of 34 volts, being 408 watts.

The reason of our not giving fuller details in our letter of August 24th was, that we did not think it would prove of sufficient interest to the readers of this journal, seeing that ours is *only an English* designed machine.

Had this been invented by Mr. Edison—as it is quite possible it may be at some time or other, providing we abandon the design, and he lives long enough—the results would no doubt have occupied about four or five pages of most of our scientific papers and journals, and looked upon as remarkable and interesting.

It is very kind of the Edison Company to publish instructions on how to make a small Edison dynamo, and then almost as good as tell their readers they can *not* make one, and *dare not*, even if they could.

To prove that the proportioning of their machine is at fault, we shall be only too pleased to suggest the necessary alterations to any of your readers who are desirous of making one of these, so that the machine shall give a much better result in every way.

We trust that our remarks will prove to the readers of this Journal that even regarding small dynamos, as well as all other machines and apparatus, we can still hold our own with those "cute Yankees," even Mr. Edison & Co.

Austin and Myers.

September 8th, 1891.

[We should almost imagine our correspondents have taken a page from Dr. Silvanus Thompson's book. See our "Notes" columns.—EDS. ELEC. REV.]

F. L. S.—In our article on the battery in question, we distinctly indicated that the whole arrangement was decidedly open to criticism, and we did not accept it as being possibly a useful battery as you seem to imagine.—EDS. ELEC. REV.